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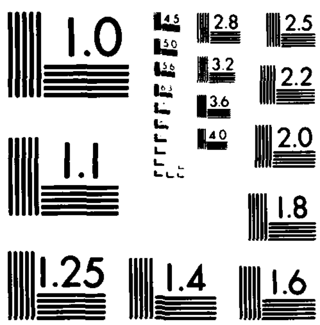

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EAST ST. LOUIS & VICINITY, ILLINOIS

CAHOKIA CANAL DRAINAGE AREA

MADISON and ST. CLAIR COUNTIES, ILLINOIS

ENVIRONMENTAL

412372

INVENTORY

REPORT

Volume 1 of 6

Prepared by: Environmental Researchers of Edwardsville, Inc.

Prepared for: U.S. Army Engineer District, St. Louis - Corps of Engineers

St. Louis, Missouri 1981

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This six volume set represents a thorough environmental inventory of the Cahokia Canal/Harding Ditch Drainage Area in Madison and St. Clair Counties of Illinois. It was prepared as background information for a St. Louis District Army Corps of Engineers multi-purpose planning study.

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INTRODUCTION

The Cahokia Canal Drainage Area (CCDA) is composed of three major drainage units. They are: 1) the area that is tributary to Cahokia Canal itself, either directly or indirectly, 2) Stanley Ditch Drainage Area (Chouteau, Nameoki, and Venice Levee District Drainage Area), and 3) the urban drainage area whose runoff drains into storm or combined (storm and sanitary) sewers and is taken to the Mississippi River (Figure 1-1*). The largest of the three drainage areas is the Cahokia Canal drainage area.

The important Cahokia Canal drainage area has several significant internal sub-drainage segments. One of these is that area which drains into Horseshoe Lake initially and then into the Canal; this includes the area tributary to Mitchell Ditch, Long Lake and Nameoki Ditch, as well as the area immediately adjacent to the lake. A second is that area which drains into Lansdowne Ditch and then into the Canal. A third is an area which is drained by or influenced directly by hillside runoff, which means that area upstream from the control works in the Canal at Horseshoe Lake.

The upland streams tributary to the Canal differ substantially in the size of their drainage area. Over half of the nearly forty-nine square mile upland drainage area is accounted for by Canteen Creek, the southern most upland creek in the CCDA with a drainage area of over twenty-five square miles. Judy's Branch has a tributary area of over nine square miles, School Branch over seven square miles, and Burdick Branch nearly three square miles. Four and four-tenths square

*All figures referred to are located in Volume 6 of 6 of this Environmental Inventory Report.

miles of upland drain into the County Ditch. The size of these tributary areas should be considered approximate, for the various studies that have been prepared during the past several years generally give slightly different sizes (Table I-1).

The flow of water through and out of the CCDA is structurally controlled. The outlet capacity of the Canal through the levee to the Mississippi River is 2,500 cubic feet per second. During high river stages, it is necessary to pump all flow from the Cahokia Canal. Since the maximum pump capacity is 1,240 cubic feet per second, discharge received at the end of the Canal in excess of this amount is stored in the Canal or, once the lower reach of the Canal is filled, it backs up over a 150 foot weir into Horseshoe Lake. The lake, in effect, acts as a large retention basin for the excess flow. A control structure (tainter gate) five and four-tenths miles above the pump house can be used to direct water into Horseshoe Lake until Lansdowne Ditch is clear or lowered (SIMAPC, 1975, A-15, A-16). In addition to these controls, all of the streams in the bottoms are lined with levees.

Table I-1

ESTIMATED SIZE OF UPLAND DRAINAGE AREA
CAHOKIA CANAL DRAINAGE AREA

Stream	1946 Study	1950 Study	1956 Study	1975 Study*
Judy's Branch	8.6 square miles	9.0	9.1	9.2
Burdick Branch	2.9 square miles	3.0	2.8	2.8
Schoolhouse Branch	7.4 square miles	7.5	7.2	7.2
Canteen Creek	21.6 square miles	22.5	22.2	25.3
County Ditch	4.4 square miles		.5	4.4
Small Upland Area I	1.2 square miles			
Small Upland Area II	1.5 square miles			

*SIMAPC, 1975, A-15

THE CAHOKIA CANAL DRAINAGE AREA SYSTEM

The "natural" drainage system of the CCDA, as best as can be determined, had many of the features of the classic floodplain drainage system (Figure I-2). There was a major river, the Mississippi, and many associated sloughs in the relatively recently reworked eastern edge of this river. There was also a traditional "yazoo" stream, Cahokia Creek, which entered the American Bottoms near its northern end, flowed southward and parallel to the Mississippi River along the base of the bluffs for several miles before it meandered westward and then turned southward once again, finally discharging into the Mississippi River near the Village of Cahokia (Figure I-3). A ridge of high ground, which is still an important local topographic feature, prevented Cahokia Creek and the other upland streams that drained into Cahokia Creek from the uplands from emptying directly into the Mississippi River. In addition to these features, the CCDA had a cut-off meander lake, Horseshoe Lake, another old cut-off meander occupied in part by swamps and in part by McDonough Lake, and a slough lake, Long Lake. Indian Lake was another lake that once existed in the study area (Figures I-3 and I-4). The CCDA was also peppered with low areas of varying size, many of which at periods of rainfall contained water. Finally, much, if not all, of the CCDA was susceptible to overbank flooding from the Mississippi River and from Cahokia Creek and its tributaries.

Structural Drainage Modification — The Channel of the Mississippi River

This "natural" drainage system presented problems for the Americans who began to occupy the CCDA and the nearby areas in the eighteenth

and ninteenth centuries. One of the first recorded efforts to influence this natural drainage system was that under the direction of Lt. Robert E. Lee. In the early 1800s, the Mississippi River had produced an island (Duncan's Island) along the Missouri shore which threatened to join with Bloody Island in Illinois and block the harbor in front of St. Louis. The river was also beginning to occupy a channel along the Illinois shore rather than continue just its course up against the Missouri side of the floodplain (Figure I-5). The leaders of the day in St. Louis, Missouri concluded that the enlargement of Duncan's Island and the movement of the river would have a decided negative impact on river shipping at St. Louis and thereby on their business. They called upon the federal government to help them maintain and if possible improve their harbor. The Corps of Engineers accepted the project and, under the direction of Lt. Lee, the Corps began in 1838 to build a dike parallel to the Missouri shore at the foot (southern end) of Bloody Island and a wing dam from the Illinois shore to the island at the head (northern end), thereby diverting the river's water back into the desired channel and washing away Duncan's Island (Figure I-5). Though completion of the northerly structure was delayed and though both structures had to be rebuilt several times, this effort and others that would come later were eventually successful in keeping the river in front of St. Louis. They also produced as a by-product the present-day railroad land on the riverfront at East St. Louis (River Engineers on the Middle Mississippi, 24-31, 44-47).

Structural Drainage Modifications -- Levees Along the Mississippi River

The first known systematic public attempt to deal with the floodwaters that are produced from time to time by the Mississippi River in the CCDA was in 1888 with the creation of the Chouteau, Nameoki, and Venice Levee District. The historical record on the origin and early activities of this district is very skimpy, but it seems that the District was formed to protect the northwesterly portion of the CCDA from flooding through the construction of levees. The exact location of this levee system is not clear. The current drainage area of the district is 7,181 acres of bottomland (Corps, 1964, 31).

The hazard presented by flooding from the Mississippi River was brought home to the residents of the CCDA and the remainder of the American Bottoms by the flood of 1903 (Figure 1-6). This flood was not the greatest on record - that which took place in 1844 was higher - but it was the first major flood since urban settlements had expanded in the Bottoms and the CCDA portion of the Bottoms. Granite City was in existence by this time and Madison, Venice, and East St. Louis had grown in population. The flood covered much, but not all, of the CCDA and its urban areas (Figure 1-6).

This natural disaster was the stimulus for the formation of the East Side Levee and Sanitary District (now called the Metro-East Sanitary District). The district was created by the Illinois Legislature in 1907 and voted in by the people within the District in 1908. Its charge was to prevent overbank flooding from the Mississippi River and to improve drainage within the area of the district (ESLSD, 4). The levee district did not include all of the Bottoms nor all of the CCDA, nor did it include

all the area which was tributary to the Bottoms. The boundaries of the District were established to include the Bottomlands benefited by the protection from flooding by high water of the Mississippi River furnished by front and flank levees (Engineers Committee, 1946, 6). These conditions would make solutions to the drainage problems still in existence in 1979 that much more difficult.

The District moved rapidly to construct a levee system to keep the Mississippi River water out of the Bottoms. This meant the construction of riverside levees, some of which tied into existing railroad embankments, and the construction of flank levees, which ran from the bluffs westward to the riverfront levee. The riverfront levee, ESLSD projects #2-7 and #2-9, cost $2,381,552.12 (Illinois, 1950, 32). This levee system, which was built initially in the period 1910-1917 (SIMAPC, 1975, 10) (The 1950 State of Illinois Report says 1911-15, page 32) has been improved and changed somewhat in its location over the years, but the one in operation today is very similar to the original.

The improvement of the levees began with the Federal Flood Control Act of 1936. This act authorized the raising of the existing levees (six and one-tenths miles of riverfront levee, four and eight-tenths miles of upper flank levee, four and nine-tenths miles of lower flank levee), the construction of nine-tenths of a mile of new riverfront levee and three and one-tenths miles of riverfront floodwall and associated appurtenant works. The project levee grade was fifty-two feet on the Market Street gage, which produced a 200 year frequency flood protection (zero gage on the

Mississippi River at St. Louis is equivalent to 379.94 feet above mean sea level (ESLSD, 3) while flood stage is thirty feet (SIMAPC, 1975, 9). The project was to be complete in federal fiscal year 1964 and involved federal expenditures of $17,344,254 as of 1962 with an estimate of $3,456,000 to complete the project (Corps, 1974, 22-23).

Another levee project was at the Engineer's Depot. "Under authority of the Act of July 2, 1940, Title II of the first War Power Act of 1941, Act of Congress, December 18, 1941 (Public Law 354, 77th Congress and Executive Order No. 9001, dated December 27, 1941) approximately two miles of the levee protecting the Granite City Engineer Depot was constructed to the 1935 approved grade and section, at an estimated Federal cost of $385,000. This construction eliminated the need for approximately one and eight-tenths miles of existing East Side Levee which was degraded during the construction of the depot." (Illinois, 1950, 31).

The construction of the Chain of Rocks Canal around a rock ledge in the Mississippi River had an impact on the levee system of the CCDA, along with improving river transportation. Approximately ten miles of parallel levee was built along the Canal from material obtained during the excavation of the Chain of Rocks Canal. The embankment was designed and constructed to provide protection against a flood of about 200 year frequency. This new major levee also eliminated the need for reconstruction of the existing East Side Levee and Sanitary District and Chouteau, Nameoki and Venice levees, which became unneeded in this portion of the CCDA. Operation and maintenance of the Chain of Rocks Canal and the canal levees are the

responsibility of the U.S. Army Engineer District, St. Louis (Corps, 1964, 23; River Engineers, 115).

As a result of all this effort, there is a system of front and flank levees, built originally by the East Side Levee and Sanitary District and revised and upgraded by the Corps of Engineers, that do provide substantial protection against flooding from the Mississippi River. In 1844 the Mississippi River reached a flood stage of forty-one and three-tenths feet. In 1785 the flood estimate is that the river reached forty-two feet. But on April 30, 1973 it rose to forty-three and three-tenths feet, a record height (River Engineers, 135-136). The CCDA, with its fifty-two foot levees, was not flooded.

Structural Drainage Modification — Interior

But the construction of a levee system against the Mississippi River unfortunately did not solve all the flooding problems in the CCDA. The water brought into the Bottoms and the CCDA via the upland streams that drain into it was and is a source of substantial interior flooding. Other causes were and are the slow drainage of water from the basically flat bottom surface and the collection of water in the natural low spots. The chief culprit, however, was Cahokia Creek which drained several miles of the American Bottoms but which also had to handle the runoff from over 290 square miles of its upland drainage area. Water was also sent into the Bottoms and then into Cahokia Creek via the other upland streams, Judy's Branch, Burdick Branch, Schoolhouse Branch, and Canteen Creek.

The early East Side Levee and Sanitary District Engineers must have recognized that water from these upland sources, especially

Cahokia Creek, was just as wet and almost as dangerous as that from the Mississippi River itself. One of the first things the District did was to divert the water from Cahokia Creek and its tributary, Indian Creek, directly across the Bottoms to the Mississippi River via a Diversion Channel (Figure I-7). This meant that large quantities of runoff went directly across the Bottoms (and the CCDA) rather than through it. This Cahokia Diversion Channel which cut through the ridge between the Cahokia Creek and the Mississippi River was essentially complete by 1911 (Corps, 1964, 23). Part of this construction involved the building of the previously discussed northern flank levee of the ESLSD levee system. As constructed, the project provided an open channel having a bottom width of one hundred feet with side slopes of one on two and having fifty foot berms and spoil banks on either side of it and a dam and spillway near its outlet at the Mississippi River together with the necessary railroad and highway bridges. The cost of the project was $1,193,611.84 (Illinois, 1950, 32). The low water dam built near the end of the Diversion Channel was designed to reduce the downward cutting and meandering actions of the stream whose gradient was increased (Corps, 1964, 24). The beheaded and straightened Cahokia Creek was renamed the Cahokia Canal. A similar project, the Prairie du Pont Diversion Channel, was built on the south end of the Bottoms and completed in 1917 (Illinois, 1950, 32).

The East Side Levee and Sanitary District (ESLSD) which handled all of the interior drainage work also dealt with the removal of the runoff in the urban areas west of the immediate Cahokia Canal Drainage Area. This involved the construction of sanitary-storm sewers

and associated pumping stations along the Mississippi River (Table I-2) (SIMAPC, 1975, 62).

There have also been some recent drainage extensions. Nameoki Ditch was built to help in the removal of urban stormwater from the eastern part of the Granite City area (ESLSD projects 15, 15A, 15B). Schoenberger Creek was improved to deal with urban runoff in the south-western part of the study area (ESLSD project 14).

The ESLSD engineers did not look upon Cahokia Creek and Channel as the final answers to the American Bottoms' interior drainage problem for they proposed very early in the life of the District the construction of a major drainage ditch along the base of the bluff to take all of the upland water from Judy's Branch and the upland streams and direct the water under controlled conditions southward to the Prairie du Pont Diversion Channel (Figure I-8). Because of the inability to finance the project, however, only 14,000 feet of the proposed 86,000 feet of the diversion canal were completed. Land that was to have been canal right-of-way is now the site of homes, schools, businesses, and major roads and highways (SIMAPC, 1975, 11).

The nature of the current Cahokia Canal drainage system is clearly described in a 1956 report of Horner and Shifrin to the Corps of Engineers. The report states:

"Runoff to Upper Cahokia Canal and Natural Storage Areas North of the Canteen Creek Junction. Cahokia Canal between the junction with Canteen Creek on the south and Judy's Branch on the north is maintained as a dredged canal trapezoidal in cross section has

Table I-2

Existing Pumping Stations

	Name	Type	Location[a/]	No. of Pumps	Capacity	Jurisdiction
1.	CN & V Pumping Station	Perimeter Levee	Levee Station 272+50	3	75.0	CN & V[b/]
2.	Granite City Pumping Station	Perimeter Levee	Chain or Rocks Canal Station 46+70	4	406.0 cfs	Federal Govt.
3.	Granite City Left Pumping Station No. 1	Perimeter Levee	Levee Station 783+01	2	11.1 cfs	ESLSD[c/]
4.	Granite City Engineer Depot Left Pumping Station	Perimeter Levee	Levee Station 798+16	4	66.7 cfs	Federal Govt.
5.	Granite City Left Pumping Station No. 2	Perimeter Levee	Levee Station 815+00	2	16.0 cfs	ESLSD
6.	Granite City Left Pumping Station No. 3	Perimeter Levee	Levee Station 846+41	2	11.1 cfs	ESLSD
7.	Madison Pumping Station	Perimeter Levee	Levee Station 861+61	3	300.0 cfs	ESLSD
8.	Venice Pumping Station	Perimeter Levee	Levee Station 891+22	3	90.0 cfs	ESLSD
9.	North Pumping Station	Perimeter Levee	Levee Station 1009+00	5	1382.0 cfs	ESLSD

a/ Corps of Engineers Levee Station numbers.
b/ Chouteau, Nameoki and Venice Drainage and Levee District.
c/ East Side Levee and Sanitary District.

Source: US Army Engineer District, St. Louis Corps of Engineers, St. Louis, Missouri, East St. Louis and Vicinity, Illinois, July 1964; and James Spanos, East Side Levee and Sanitary District.

varying in width from ten feet in the vicinity of Judy's Branch to thirty-two feet above the junction with Canteen Creek. Large natural storage areas are available to receive spill from the Canal when the capacity of the channel is exceeded. These natural storage areas are referred to in this report as 1) North Storage area, which lies north of the Illinois Central Railroad, and receives the overflow from Cahokia Creek, County Ditch and Mitchell Ditch; and 2) Upper McDonough Lake Storage area, which receives direct inflow from Lateral Ditch No. 10 and a number of other small hill areas, and from about 2,550 acres of bottoms lying north of the Illinois Terminal Railway, and east of Cahokia Canal. Inflow into the Upper McDonough Lake Storage area other than this direct runoff will occur from spill out of Judy's Branch and out of Burdick Branch, whenever the hydrograph values of these two streams exceed their channel capacities. As explained later in the report, when the lower reach of Judy's Branch and of Burdick Branch exceed these respective amounts, the excess flow will enter the Upper McDonough Lake Storage area. The Upper McDonough Lake Storage area receives no spill from Cahokia Canal under any of the four design storms analyzed in this report, and consequently, does not float on the Canal, except during the tail end of the recession side of the discharge hydrograph."

"A third large natural storage basin is the Lower McDonough Lake Storage area which receives direct inflow from Laterals 8 and 8-A, from a number of other small hill areas, and from about 2,575 acres of bottoms. Overbank spill from Schoolhouse Branch occurs when the hydrograph values exceed about 2,900 cubic feet per second

and from Canteen Creek when the runoff hydrograph exceeds about 3,300 cubic feet per second for the channel north of Highway 40."

"Openings in the bank of Cahokia Canal permit an interchange of flow between the Canal and the storage area. During the rising side of the discharge hydrograph of Cahokia Canal, there is inflow into Lower McDonough Lake Storage area; during the recession side, the storage area floats on Cahokia Canal. The discharge in Cahokia Canal above the Control Works is affected at all times by the elevation of the water surface in Lower McDonough Lake Storage area."

"Runoff to Upper Cahokia Canal East of Control Works. Flow in upper Cahokia Canal, immediately east of the Control Works, results from discharge out of the Canal north of the Canteen Creek junction, and out of Canteen Creek. Canteen Creek flowing bank full has a capacity of approximately 3,300 cubic feet per second along its lower reach north of Highway 40 and about 4,900 cubic feet per second in the middle reach south of Highway 40. The capacity in the upper reach west of Highway 157 where the grade is relatively steep, is approximately 7,200 cubic feet per second. Flows in excess of 4,900 cubic feet per second will spill out of Canteen Creek in the middle reach, and migrate southwestwardly into a natural storage area of about 450 acre-feet capacity located south of Highway 40 and east of Black Lane. Inflow into this storage area in excess of its capacity will overflow across Black Lane and into the upper Spring Lake area which is tributary to Harding Ditch. Flows in excess of 3,300 cubic feet per second but less than 4,900 cubic feet per second will remain in Canteen Creek as far north as Highway 40 where overbank

spill will occur near the entrance road to the Fairmont Jockey Club. Part of this spill will flow overland along the west side of the Creek and pond in the low area behind the south levee of the Creek west of Black Lane where it will remain until the Creek recedes. The remainder of the spill will migrate along the east side of the Creek through the Jockey Club property, and thence into the lower McDonough Lake Storage area. It was assumed in the storage computations discussed later in this report that the spill was equally divided as between that which entered the Lower McDonough Lake Storage area and that which flows westwardly into the low area west of Black Lane along the south side of the Creek."

"Horseshoe Lake Inflow. Runoff into Horseshoe Lake occurs from 1) inflow over the spillway during the rising side of the Upper Cahokia Canal hydrograph, and during the recession side, as long as the water surface elevation in the Canal is above the level of the Lake; 2) inflow from bottoms areas bordering the Lake; 3) direct rainfall on the Lake; 4) discharge from Nameoki Ditch; and 5) discharge through Elm Slough. Elm Slough receives inflow from Long Lake and from Mitchell Ditch, the outlets of both of which are restricted by relatively small culverts. The Long Lake outflow attains a maximum value of about sixty-five cubic feet per second, and the Mitchell Ditch outflow, about ninety cubic feet per second. Between Long Lake and the Nameoki Ditch watershed line, there is one large area (northern part of area H_1) draining into Dobrey Slough, which is without an outlet, and a second area (southern part of area H_1) south of the Dobrey Slough, which drains through an eighteen inch pipe culvert into

Horseshoe Lake. Neither of these latter two areas contribute significantly to the runoff into Horseshoe Lake."

"Lower Cahokia Canal Discharge. Discharge quantities in the Lower Cahokia Canal above the North Pumping Station are dependent not only on the direct discharge into the Canal from Lansdowne Ditch and the runoff from the areas immediately adjacent to the Canal, but also on flow released through the Horseshoe Lake Control Works into the Canal. Flow through the Control Works can consist entirely of water out of the upper canal or partly of water released out of impoundment and partly out of the canal. In the studies which follow it is shown that water from the Upper Canal which is allowed to flow through the gates of the Control Works while the lake is still rising is critical to the operation of the Lower Canal and the Pumping Station."

"As hereinbefore described the Lansdowne Ditch area drains a builtup section of East St. Louis which must be protected against storm water flooding. For this reason the water surface elevation in Cahokia Canal at the junction with Lansdowne Ditch is critical in the operation of the North Pumping Station and Horseshoe Lake Control Works. In the Hillwaters Diversion Project Study it was found that the maximum acceptable water surface elevation in Cahokia Canal at the Lansdowne Ditch connection when the Ditch is discharging 800 cubic feet per second is about 407 feet. When the Ditch is discharging 1,400 cubic feet per second the maximum acceptable elevation is about 404 feet."

"Lansdowne Ditch is constructed through Indian Lake area located north of Highway 40. To prevent spill out of the Ditch into Indian

Lake, levees were built along each bank of the Ditch to an elevation of three feet above design hydraulic grade. Backwater gates on pipe culverts through the levees prevent Indian Lake from discharging into Lansdowne Ditch except during low flows in the Ditch."

"As hereinbefore described, Indian Lake is protected from outflow from Cahokia Canal by backwater gates on the four foot by five foot box culvert which serves as the principal outlet for the Lake when the water level in Cahokia Canal permits outflow from the Lake. For the storms covered by this report discharge from Indian Lake into Cahokia Canal did not occur during the rising side of Cahokia Canal hydrograph and therefore did not contribute to the Canal discharge." (Horner and Shifrin, 1956, III-1 through III-5).

The limitations of the existing system described in the above Horner and Shifrin statement and as presented in the 1975 SIMAPC report are sufficiently important to require emphasis. Horner and Shifrin give the following capacities for the major streams: lower reach of Judy's Branch (3,000 cubic feet per second (cfs)), Burdick Branch (1,100 cfs), Schoolhouse Branch (2,900 cfs), Canteen Creek north of Highway 40 (3,300 cfs), and Canteen, middle reach, south of Highway 40 (4,900 cfs) (Horner and Shifrin, 1956, III-1, III-2). The SIMAPC report which seemingly did not measure the stream capacities at exactly the same locations, gives lower figures (Table I-3), but the finite capacity of the ditches is clear. The SIMAPC report in fact gave the capacity of some of the ditches as that of just a five year storm and that some ditches were overtaxed with just a two year storm (SIMAPC, 1975, A-17).

Table I-3

Peak Discharges vs. Storm Frequency in the CCDA

Location	Existing Capacity (cfs)	1 Year (2.1")	2 Year (2.7")	5 Year (3.7")	10 Year (4.5")	25 Year (5.8")	50 Year (7.0")	100 Year (8.4")
County Ditch 3800' North of N & W RR	710	530	880	1550	2130	3120	4060	5180
Judy's Branch 4100' West of Ill Rt. 157	1510	900	1560	2590	3510	5060	6510	8200
Burdick Branch 300' East of Junction with Cahokia	580	300	510	900	1240	1840	2390	3030
Cahokia Canal 9400' North of Ill Term. RR	2120	1090	1810	3460	4380	5660	6700	7810
Cahokia Canal 7000' NE of Sand Prairie Lane	2700	1200	1960	3620	4740	6490	7930	9540
Canteen Creek 300' East of Sand Prairie Farm	2070	900	1430	2420	3260	4670	6010	7580
Cahokia Canal 1700' East of Alton & Southern RR	4010	1960	3270	5980	8050	11,480	14,530	18,060

(SIMAPC, 1975, A-17)

PLANNING FOR INTERIOR DRAINAGE

Engineers Committee Plan of 1946

The CCDA drainage system was severely tested by a major storm that occurred in the area from August 14 to 16, 1946. In a thirty-six hour period, thirteen and fifty-six hundreths inches of rain were recorded at the St. Louis Weather Bureau Station (Engineers Committee, 1946, 2). Total rainfall over the various watersheds ranged from eleven and seven-tenths to fifteen and five-tenths inches (Illinois, 1950, 30). This storm followed a rainy period during the month of August which built-up the soil moisture to a very high condition (Table I-4).

The runoff from the storm of August 14 to 16, 1946 was substantial. The excess rainfall varied from just less than nine inches to nearly eleven inches. The total volume of water discharged through the major upland streams was 22,420 acre-feet (Illinois, 1950, 37). Over half of the computed runoff was from Canteen Creek. The peak discharge of the streams was also much more than their capacity (Table I-5).

The 1946 report of the Engineers gives the same massive runoff, though the figures are somewhat different (Table I-6). The uplands contributed almost as much runoff as the Bottoms and Canteen Creek produced almost as much runoff from the uplands as all of the rest of the upland drainage area combined.

Substantial floods resulted from this storm, for "the amount of water entering and originating within the boundaries of the Levee District was so great that all facilities were far overcharged. Flood waters left their normal course and proceeded across country, entering other subdivisions of the drainage system. Specific instances of this

Table I-4

EARLY STORMS, AUGUST 1946

Period	Rainfall
August 2-5, 1946	4.86 inches
August 6-12, 1946	0.49 inches
night of August 12	0.41 inches
night of August 13	0.98 inches

Source: (Engineers Committee, 1946, 2)

Table I-5

COMPUTED RAINFALL AND RUNOFF
Storm of August 14-16, 1946

Stream	Peak Discharge c.f.s.	Total Volume, Acre-Feet
Judy's Branch	5,330	4,280
Burdick Branch	2,250	1,390
Schoolhouse Branch	5,160	3,900
Canteen Creek	9,680	12,850

Source: Illinois, 1950, 37.

Table 1-6

RUNOFF FROM THE STORMS OF AUGUST 14-16, 1946

Area	Drainage Area in Acres	Runoff in Acre-Feet Storm # 1	Storm # 2	Total
Upland Area north of Highway 40	16,700	5,200	8,600	13,800
Big Canteen Creek	14,700	4,700	8,500	13,200
Subtotal Uplands	31,400	9,900	17,100	27,000
Bottoms Tributary to Project # 11 above Sand Prairie road and north of Highway 40	16,500	3,200	7,000	10,200
Horseshoe Lake Area, including Elm Slough, Long Lake, Nameoki Ditch and south to Project # 11	16,200	3,500	7,800	11,300
Indian Lake Area including Lansdowne Ditch and Stockyards	5,500	1,500	3,000	4,500
Subtotal Bottoms	38,200	8,200	17,000	26,000
TOTALS	54,700	18,100	34,900	53,000

After Table I "Runoff - Northern Section Tributary to Project 11 System", Engineers Committee, 1946

occurrence are as follows:"

"The flood flow of Big Canteen Creek far exceeded the capacity of the Canteen Creek Canal. These waters broke out to the west and proceeded across country to the area of the State Park, flooding U.S. Highway 40."

"The flood flow of Little Canteen Creek, which normally is directed through the B&O Railroad into the upper end of Harding Ditch, also appears to have been unable to follow this course and proceeded westwardly between the B&O and Pennsylvania Railroads and was finally disposed both to the north and south of these railroads. Evidence of high water marks seems to indicate that the flows in Little Canteen Creek exceeded the capacity of the channel along the slopes, and the overflows occurred on the slopes with the water spreading from these overflows in the bottoms both to the north and south of the B&O Railroad and west of the Harding Ditch. Part of this flood undoubtedly augmented the excess flow from Big Canteen Creek, and was in part responsible for the flooding of Highway 40 and the area around Fairmont race track."

"These flood waters together with those from the three northern hill streams and the runoff from the northern bottom lands completely overcharged Project 11 (Cahokia Canal) and produced new flood heights along the upper Project 11. Horseshoe Lake and the adjacent areas were completely inundated, reaching an elevation of about 418 (Memphis datum). Furthermore, in this same area in the Indian Lake basin this elevation reached 418. Fortunately the Mississippi River was not at a high stage initially as Project 11 was discharging a capacity probably well in excess of 2,000 second feet throughout the flood period. This discharge rate removed the excess flood waters in a period of about ten days

permitting highways to be reopened."

"South of the B & O Railroad the flood waters of Schoenberger Creek and that part of the flow of Little Canteen Creek which passed through the B & O Railroad overcharged the Harding Ditch to such an extent that the flood waters in the Spring Lake area were raised above the elevation of the low ridge along the Alton and Southern, and overflowed into the Lansdowne Ditch, completely flooding the Washington Park and Lansdowne areas. The flows of Schoenberger Creek broke through the levee on the west side of Harding Ditch near the L & N Railroad right-of-way causing the water to flow northwardly and westwardly through East St. Louis and further raising the high water in the Lansdowne area of East St. Louis. The situation was further aggravated by the failure at a critical time of the Lansdowne Ditch culvert under the B & O Railroad, nearly blocking the outlet of the Lansdowne Ditch. Emergency work by the Levee District removed the debris and restored this outlet in about four days' time, after which the flood waters quickly receeded."

"In East St. Louis and in the Tri-Cities generally the sewer systems were quite inadequate to remove the flood waters, and local flooding occurred over large parts of these City areas. However, because the intensity of the rainfall for periods of one and two hours was not appreciably above the ten year frequency, this local flooding was not more serious than that which occurred in the shorter and more intense storms of the previous four years."(Engineers Committee, 1946, 14-16). "Damage in Madison and St. Clair Counties was estimated by the U.S. Weather Bureau at $6,000,000"(Illinois, 1950, 30).

In response to this flooding, Mayor Connors of the City of East St. Louis appointed an Engineers Committee ". . . to review the drainage

facilities for the American Bottoms area in Illinois, the plans heretofore proposed or adopted for further improvement of these facilities, and to make recommendations with respect to further desirable and possible feasible modifications of these plans which should be considered in light of the floods and flood damages in this area, which resulted from the storm of August 14th to 16th, 1946". (Engineers Committee, 1946, 1). Seemingly the procedure that was followed was for Horner and Shifrin to prepare a report as to their suggestions and for the Engineers Committee to comment on the suggested Horner and Shifrin proposals. The engineers whose suggestions are included in the report are: James G. Cooney (Belleville), S.H. Kernan (ESLSD), B.C. McCurdy (Department of Roads and Bridges, St. Clair County), H.A. Kluge (Madison County Superintendent of Highways), J.F. Cronin (Sheppard, Morgan and Schwaab), J.E. Weinel, (East St. Louis), Max Suter (Illinois State Water Survey), C.M. Roos (East St. Louis and Interurban Water Company), R.E. Smyser, Jr. (Corps of Engineers), James Ogg (East Alton), and David J. Johnston (City Engineers, East St. Louis and Chairman of the Engineers Committee).

The Engineers Committee report presented four alternatives, all of which are purposely engineering solutions to the flood problem. The alternatives are:

> Alternative # 1
> "The construction of a hillside intercepting channel from Judy's Branch to Prairie Du Pont Creek, utilizing part of the existing Right of Way of the East Side Levee and Sanitary District along the bluffs from Prairie Du Pont Creek to State Street, and the internal drainage of the bottoms by the enlargment of present drainage structures."
>
> Alternative # 2
> "The construction of a hillside intercepting channel from Big Canteen Creek to Prairie Du Pont Creek, utilizing the

existing Right of Way of the East Side Levee and Sanitary District along the bluff from Prairie Du Pont Creek to State Street, and the internal drainage of the bottoms to be made by enlargement of present drainage structures, for that portion of hillside drainage that is not diverted by the proposed hillside interception."

Alternative # 3
"The construction of internal drainage structures and flood detention reservoirs of sufficient size to accommodate maximum hillside runoff, and interior drainage."

Alternative # 3a
"The construction of a hillside intercepting channel from Schoenberger Creek to Prairie Du Pont Creek along the bluffs, utilizing a portion of the Right of Way of the East Side Levee and Sanitary District along the bluffs from Prairie Du Pont Creek to State Street, and the construction of internal drainage channels and flood detention areas of sufficient size to carry the rest of the hillside runoff and internal drainage."

(Engineers Committee, 1946, cover letter 2,3)

The Engineers Committee also produced some recommendations in regards to storm water protection of the American Bottoms. The recommendations were:

"(1) A detailed study and engineering report should be made by a competent engineer.

(2) The American Bottoms should be protected against any type of storm that may occur.

(3) The best type of protection would be the diversion of contributing hillside runoff into the Mississippi River, by a gravity flow channel located along the bluffs of the American Bottoms into Prairie Du Pont Creek. The extent and size of this channel should be capable of carrying minimum storm flows.

(4) The interior drainage should be improved or changed to prevent silting up and destruction of present natural storage basins.

(5) The present program of the East Side Levee and Sanitary District should be to continue on maintenance and construction, so that the American Bottoms will be protected to the maximum extent, pending construction of facilities for maximum storm flows. The present program of the District can be incorporated into the master storm water relief plan without loss.

(6) An agency should be set up capable of financing and constructing flood water protection for the American Bottoms. This program should be coordinated with the Metropolitan Plan Association."

(Engineers Committee, 1946, cover letter 9)

The Engineers Committee leaned strongly on the side of a major floodway south to Prairie du Pont, alternative # 1, though some were in favor of the other alternatives. Alternative #1 was, in fact, a resurrection of the old project No. 12 of the East Side Levee and Sanitary District, which was for a foot-hill canal extending the whole length of the District to collect the flood flows of the hill streams and discharge them into Prairie du Pont Creek at the southern end (Engineers Committee, 1946, 24-25). The engineers were not too impressed with the design of the old project, for in their view "if this project had been built in the capacity of what the cross sections then proposed it would have been completely inadequate to have carried away the flow of the hills' streams, the levee would have been broken, and this hill water would have spread over the internal area, probably even more catastrophically than the actual occurrence of 1946". (Engineers Committee, 1946, 25).

The Engineers had some thoughts about the nature of the necessary drainage channel, "It is fundamental to a project of this kind that if it is constructed at all its levee must never be overtopped, and therefore, it must have capacity to carry the greatest possible floods and safe levee free boards above the water surface. This type of project has been given further consideration, sections meeting the above requirements have been estimated and a rough estimate of cost has been prepared. It will be seen in this estimate in Table III that not only is the cost of the canal itself very great, but the develop-

ment of the area through which it runs has proceeded to such an extent that a great deal of improved land would have to be acquired and a very large number of bridges would have to be constructed or reconstructed."

"However, this project at the cost indicated in the above table would have completely served to carry off the hill drainage. It is considered in this report that the construction of this project together with that for the Lansdowne Ditch as now adopted by the Levee District and some small additions and improvements to the Harding Ditch system to provide the stormwater outlets necessary for areas east and west of Harding Ditch north of Park Lake in Grand Marais State Park would be a complete solution for handling the flood waters of the 1946 storm, excepting for the families required within the incorporated cities along the river front. In addition to the projects as set up above, complete solution for stormwater drainage would require further examination of the levees along the north floodway and possibly some further strengthening to prevent any Indian Creek or upper Cahokia Creek water from entering the area, and would also require a considerable enlargement of the Prairie du Pont floodway along the southern flank of the Levee District. The present design for the floodway of Prairie du Pont, between the flank levee of the East Side Levee and Sanitary District on the north and the contemplated flank levee of the Prairie du Pont Levee District on the south, does not contemplate the introduction of the excessive amount of stormwater runoff of the proposed hillside intercepting channel at Prairie du Pont." (Engineers Committee, 1946, 27). The total cost of alternative # 1 was estimated at $20,250,000 (Engineers committee, 1946, Table III).

State of Illinois Plan of 1950

The 66th General Assembly (1949) of the State of Illinois seemingly responded by Senate Bill No. 427 to the recommendation of the 1946 Engineers Committee for a detailed study of the hillside-produced drainage problems in the American Bottoms, for in 1950 the State through the Department of Public Works and Buildings of the Division of Waterways released a report entitled "Proposed Hillside Diversion Project Madison and St. Clair Counties, Illinois". The focus of the report was on the flood and major drainage problems in the American Bottoms area south of the Cahokia Diversion Channel that are caused by the runoff from the tributary upland areas, with the major emphasis of the report on that segment of this area between Judy's Branch and Prairie du Pont Floodway. As per the report:

> "The major existing flood problems are related to the flooding caused by the fact that the present interior drainage facilities of the area are entirely inadequate to dispose of the runoff from both the bottomlands and the tributary upland areas during major floods. Investigations indicate that the existing drainage system would be adequate, with relatively minor improvements, to handle major flood runoff fromthe bottomlands area if the runoff from the upland watersheds were excluded or held back until bottomlands runoff has ceased and been disposed of." (Illinois, 1950, 36)

The consultants for the State, Horner and Shifrin, used three storms in their analysis of the drainage problem and the development of drainage recommendations. The previously reviewed storm of August 14 to 16, 1946 was selected as the storm against which a reasonable degree of protection should be provided. The one hundred year storm, a synthetic storm, was the second. It has a much greater probability of occurrence than the August 14 to 16, 1946 storm. The one hundred year storm is nearly equivalent to the actual storm of July 8 and 9, 1942 when approximately nine and thirty-five hundreths inches of rain fell (Illinois, 1950, 26, 36-38). The third was a ten year storm.

Six different plans were prepared by Horner and Shifrin. Each of them proposed to provide the same degree of protection, including some protection against the storm of August 14-16, 1946 (Illinois, 1950, p. 64). One of the plans, alternative 4A, was chosen as the selected plan and was prepared in much greater detail (Figure 1-9).

All of the plans proposed to solve the drainage problems in the hillside-influenced segment of the American Bottoms by structural means. The measures studied were a diversion channel, temporary impoundments, and pumping of storm water (Table 1-7).

Just one of the plans proposed to solve the drainage problem solely by diversion of the runoff from the upland streams. Alternative plan #1 suggested the diversion of all of the runoff from the upland tributary area to the Prairie du Pont Floodway (and via the floodway to the Mississippi River) through a new diversion channel at the base of the bluffs. The channel would extend from Judy's Branch in the Cahokia Canal Drainage Area to Prairie du Pont Floodway at the southern end of the American Bottoms. The existing right-of-way for Canal # 1 would be used for a segment of the proposed new and much longer diversion channel. The plan, of course, is basically the same one proposed by the East Side Levee and Sanitary District just after its creation and recommended again in 1946 by the Engineer Committee.

The other five plans proposed to handle the runoff by various combinations of a diversion channel, impoundments, and pumping. All five plans included a diversion channel southward to the Prairie du Pont Floodway. What varied from plan to plan was the upland streams that would be connected to this channel. Two of the plans proposed that the channel be extended all the way to Canteen Creek. Three of the plans

Table I-7

Components of Drainage Plans State of Illinois, 1950

(Adapted from 1950 Report, pp. 38-57)

Plan	Current Drainage Basin	Diversion Channel	Impoundments		Pumping
			Location	Structures	
Alternative Plan # 1	Cahokia Canal, Harding Ditch, & Canal # 1	Base of bluff from Judy's Branch to Prairie du Pont Floodway. *Utilizes Canal # 1* right-of-way.	None	None	None
Alternative Plan # 2a	Cahokia Canal, Harding Ditch, & Canal # 1	Base of bluff from Canteen Creek to Prairie du Pont Floodway. Same alignment, leveed reaches, and levee dimensions for the corresponding reach as plan # 1.	None	None	None
	Cahokia Canal		McDonough Lake. Runoff from Lateral Ditch # 8A to Judy's Branch. Water evacuated through Cahokia Canal.	Grated double 9 ft. by 8 ft. culvert with spillway	Increase of North Pumping Station by 400 c.f.s.

Table I-7 cont.

Plan	Current Drainage Basin	Diversion Channel	Impoundments		Pumping
			Location	Structures	
Alternative Plan # 3	Harding Ditch, Canal # 1	Base of bluff from Schoenberger Creek to Prairie du Pont Floodway. Same alignment, leveed reaches, and levee dimensions for the corresponding reach as in plan number 1.	None	None.	None
	Harding Ditch		Crooked Lake. Run-off from small upland tributary area between Schoenberger Creek and Little Canteen Creek. Water evacuated through Harding Ditch.	4 ft. by 5 ft. concrete box culvert with sluice gate.	None
	Cahokia Canal		McDonough Lake. Runoff from Canteen Creek to Judy's Branch. Evacuated through Cahokia Canal.	Gated double 9 ft. by 8 ft. culvert with spillway	increase of North Pumping Station by 800 c.f.s. Evacuate impounded water in 18 days.

Table I-7 cont.

Plan	Current Drainage Basin	Diversion Channel	Impoundments		Pumping
			Location	Structures	
Alternative Plan # 4	Harding Ditch and Canal # 1	Low level diversion channel at base of bluffs, from Schoenberger Creek to Prairie du Pont Floodway. Same alignment and leveed reaches for the corresponding reach as in plan # 1, but the levees are lower	None	None	New pumping station 2,400 c.f.s. against static head of 23 ft. 14 ft. by 18 ft. Gated gravity outlet.
	Harding Ditch		Crooked Lake. Run-off from small upland tributary area between Schoenberger Creek and Little Canteen Creek. Evacuate through Harding Ditch. Same as plan number 3.	4 ft. by 5 ft. concrete box culvert with sluice gate. Same as plan number 3	None

Table I-7 cont.

Plan	Current Drainage Basin	Diversion Channel	Impoundments		Pumping
			Location	Structures	
Alternative Plan # 4 (continued)	Cahokia Canal		McDonough Lake. Runoff from Canteen Creek to Judy's Branch Evacuate through Cahokia Canal. Same as plan # 3.	Gated double 9 ft. by 8 ft. culvert with spillway Same as plan # 3	Increase of North Pumping Station by 800 c.f.s. Evacuate impounded water in 18 days. Same as plan # 3.
Alternative Plan # 5	Cahokia Canal, Harding Ditch and Canal # 1	Base of bluff from Canteen Creek to Prairie du Pont Floodway. Same alignment, leveed reaches, levee dimensions for the corresponding reach as plan # 1. Same proposal as plan number 2a.	Three upland detention reservoirs capacity of 6,000 acre feet.	Spillway	None
	Cahokia Canal	None	McDonough Lake. Runoff from Lateral Ditch #8A to Judy's Branch. Water evacuated through Cahokia Canal. Same as plan # 2a	Gated double 9 ft. by 8 ft. culvert with spillway. Same as plan # 2a	Increase of North Pumping Station by 400 c.f.s. Same as plan # 2a

Table 1-7 cont.

Plan	Current Drainage Basin	Diversion Channel	Impoundments		Pumping
			Location	Structures	
Alternative Plan # 4a (Selected Plan)	Harding Ditch and Canal # 1	Base of bluff from Schoenberger Creek to Prairie du Pont Floodway. Seemingly same alignment as other plans for the corresponding reach	None	None.	390 c.f.s. at static head of 20 ft. Gated triple 10 ft. by 12 ft. Concrete box culvert
	Harding Ditch	None	Crooked Lake. Runoff largely from Bunkum Road Ditch (Lateral # 5). 535 acres of land required. Water evacuated to Harding Ditch.	5 ft by 4 ft. gated concrete box culvert.	None
	Cahokia Canal	None	McDonough Lake. Runoff from Little Canteen Creek to Judy's Branch. Intercepting and connecting channels to be built. Requires 3,500 acres of land. Water evacuated to Cahokia Canal.	Gated double 6 ft. by 6 ft. concrete culvert maximum capacity 2,000 c.f.s.	Increase of North Pumping Station by 800 c.f.s. at static head of 25 ft. Evacuate impounded water in 18 days.

suggested that the channel would extend just to Schoenberger Creek and that the runoff from Little Canteen and Canteen Creeks would be diverted northward to the Cahokia Canal Drainage Area.

Impoundments to store temporarily the water were also part of the five plans. Those proposals which extended the base-of-bluff diversion channel just from Schoenberger Creek (#3, #4, #4a) also included impoundments at Crooked Lake, with evacuation of the water into Harding Ditch. One of the plans (#5) suggested three upland detention reservoirs on streams tributary to the proposed diversion channel and a pumping station at Prairie du Pont Floodway for this channel.

McDonough Lake was the key drainage feature in almost all plans for the Cahokia Canal Drainage Area. Except for just one plan which proposed the massive diversion channel all the way from Judy's Branch to Prairie du Pont Floodway, all the plans proposed to solve the CCDA drainage problem by the temporary storage of water in McDonough Lake, while some plans added as well the diversion of Canteen Creek into the proposed new base-of-bluff diversion channel. As noted, the plans also varied as to whether or not they would send Little Canteen Creek and Canteen Creek water into the Cahokia Canal Drainage Area and the proposed McDonough Lake storage area. All but one of the plans proposed increased pumping capacity at the North Pumping Station in order to evacuate the impounded areas within a reasonable period of time (18 days).

The recommended design for the McDonough Lake Reservoir was unusual in that it was actually three reservoirs for three different-sized storms nested together.

"<u>August 1946 Design Storm</u>. For this storm, which has an extremely rare frequency of occurrence, the reservoir area would consist of all

the land below elevation 425.8 in the area defined by the main boundary levees. The north boundary levee would extend along the north bank of the Judy's Branch connecting channel from Highway 157 to its junction with the west boundary levee at the Cahokia Canal at a point about 500 feet south of Edwardsville Road. From this point, the west boundary levee would extend along the east bank of the existing Cahokia Canal southward to the existing channel of Canteen Creek at a point approximately 2,500 feet east of Sand Prairie Lane. The south boundary levee would extend easterly from this point along the north bank of Canteen Creek to the west side of Black Lane, thence northerly along Black Lane to the new connecting channel for the Canteen Creeks, and thence easterly along that channel to high ground at a point about 1,100 feet west of Highway 157. The eastern boundary would be the high ground which lies in a line roughly parallel to and west of Highway 157, with the exception of the Illinois Terminal Railroad, which would be protected on the south by a levee along the north bank of Schoolhouse Branch from high ground to the collecting channel and on the north by a similar levee extending along the northern edge of Highway S.A. 35, and of Highway 157 immediately east of McDonough Lake where a 3,900-foot reach of the highway would be raised to elevation 426.5 in order to be above maximum pool level."

"These levees would constitute the extreme boundaries of the reservoir for the maximum pool stage of 425.8, at which level the volume of storage would be 32,800 acre-feet. All these levees would have a net crown elevation of 428.0, a crown width of ten feet, and side slopes of three on one."

"One Hundred Year Storm. In view of the extremely remote probability of a recurrence of the August, 1946 design storm and of the highly productive nature of much of the land within the boundary levees, an interior system of levees would be provided which would, for the one hundred year storm and all those of greater frequency, restrict the area to be inundated to those areas which are now classified as lakes and swamps. This system of levees would divide the main reservoir area into two parts."

"In the southern end, flooding would be restricted to the area between the Cahokia Canal and Black Lane from the south boundary levee to a point roughly 2,200 feet south of the Illinois Terminal Railroad. This would be accomplished by providing a levee extending from the Illinois Terminal Railroad southwardly along the east bank of the intercepting channel to a point about 1,500 feet south of the said railroad and thence easterly to high ground at Black Lane, and by providing levees along both banks of the streams tributary to this area from the eastern limits of the main reservoir to the restricted area provided for the one hundred year storm."

"In the northern end of the main reservoir, the flooding for the one hundred year storm would be restricted to the series of lakes and swamps in the vicinity of and including McDonough Lake. This would be accomplished by one levee extending northeasterly from the east side of the intercepting channel at the Illinois Terminal Railroad to high ground on the south side of McDonough Lake and by another levee extending easterly from the intercepting channel at a point about 7,500 feet north of the Illinois Terminal Railroad to the low ground near the

northern end of McDonough Lake and thence northerly, along the western edge of the low ground, to high ground about 1,000 feet south of the Burdick Branch connecting channel. The south bank of the Judy's Branch to a point 7,500 feet north of the Illinois Terminal Railroad would be leveed to contain the one hundred year runoff."

"All these levees would have a net crown elevation of 420.0, a crown width of ten feet, and side slopes of three on one. The maximum pool stage for the one hundred year storm would be elevation 419.2 and the volume of storage would be 9,600 acre-feet."

"Ten Year Storm. For the ten year storm, which is that to be expected as common occurrence, a second system of interior levees would be provided which would confine practically all runoff to the collecting and connecting channels — this by providing a low levee along the east bank of the collecting channel from the point 7,500 feet north of the Illinois Terminal Railroad, where the one hundred year levee turned eastward, to the one hundred year levee near the Illinois Terminal Railroad, and another short section extending about 1,200 feet southward from the point where the one hundred year levee left the collecting channel and turned easterly, said point being about 1,500 feet south of the Illinois Terminal Railroad. The maximum stage for this storm would be elevation 412.8 and the volume of storage would be 2,330 acre-feet. These levees would have a crown width of ten feet and side slopes of three on one." (Illinois, 1950, 50-52).

The estimated cost of the selected plan was $5,092,000 (1950 dollars). Over two-thirds of the cost ($2,022,900) was in structure related work, with earthwork of over $1,500,000 accounting for the

majority of this cost. Transportation related work, including the rebuilding of bridges and the relocation and revision of roads, streets, and utility pipelines was one-quarter of the projected cost. The designed addition to the North Pumping Station was just over $1,000,000 while the land cost was almost three-quarters of a million dollars (Table I-8).

The study suggested that the cost of the project be divided three ways. The Corps of Engineers would be asked to pay for the addition to the North Pumping Station through the National Flood Control Program. The East Side Levee and Sanitary District would purchase the land. The State of Illinois would assume the remainder of the cost (Illinois, 1950, Appendix I, 18-21). No firm dollar figure of the benefits of the project was given. The stated justification for the project in fact makes interesting reading in light of the extensive project justification that is necessary today.

"The investigations carried out in connection with the development of the improvements proposed herein have led to the conclusion that the benefits expected to accrue as a result of the construction of such improvements cannot, by the presently known and accepted methods of analysis, be expressed directly in monetary terms. This is largely due to the intricate system of channels, levees, pumping stations and storage areas and to the fact that flow is greatly influenced by Mississippi River stages. The situation is further complicated by the fact that, during floods, the water often spills from one watershed to another."

Table 1-8

Estimated First Costs, Selected Plan (1950 Report)
Cahokia Canal Drainage Area
(adapted from Table 18, Illinois, 1950, p. 60)

Structure Related		$2,022.9*
Earth work	$1,551.4	
Lateral ditches, sewers culverts, and drainage facilities	135.7	
Drop structures	144.9	
McDonough Lake control structure	190.9	
Transportation Related		1,319.1
Railroad bridges	632.5	
Highway bridges	472.6	
Relocation & adjustment of roads and streets	189.8	
Revisions to utility pipelines	24.2	
Land Cost		710.0
Additions to North Pumping Station		1,040.0
Estimated Total Project Costs (in 1950 dollars)		5,092.0

*dollars shown in thousands of dollars

"Adequate flood control and drainage facilities, in an urban and industrial area such as this, are as necessary to the continued growth and prosperity of the area as are an adequate water supply, sewerage system, roads and streets and electrical distribution system, all of which are equally as difficult to express in terms of monetary benefits. The case is also analogous to the provision of adequate governmental services. The benefits which accrue to a city or an area as a result of adequate fire and police protection, libraries and social services, or others of like nature cannot be expressed in terms of dollars, but it is obvious that such benefits do exist and that they are of vast importance to the general well-being and prosperity of the public at large."

"In considering the benefits to the area, some idea of its present value should be borne in mind. The present assessed value of the lands and improvements in the East Side Levee and Sanitary District, exclusive of the rather large area to the east of the district, is, in round figures, $390,000,000. This figure does not include the full value of the tremendously large railroad facilities in the area, which are exempt from the provisions of the Butler Act. It is believed that the full present value of the entire bottoms area from the Prairie du Pont Floodway to the Cahokia Diversion Channel would approximate not less than one billion dollars, and as stated previously, almost all of this area is affected in some degree by the existing flood and drainage problems."

"As stated above, it has not been found practicable to express the benefits expected to accrue as a result of the improvements pro-

posed herein in monetary terms. This does not by any means obviate the fact that many extremely significant benefits will accrue and the more important of these are discussed in the following paragraphs."

"The most obvious benefit would result from the prevention of such direct overflow of the bottoms lands as now occurs as a result of the inflow of upland runoff into the area. This includes important rail and highway routes, large agricultural areas in the eastern and southern portions of the area and extensive residential and light commercial areas in Fairmont City, Washington Park and Edgemont, which were flooded to depths of from one to three feet in 1946. In this connection, important benefits would accrue to State-owned property in the Grand Marais State Park, which is also subject to frequent inundation, thus greatly impairing its recreational values."

"Another important benefit would be realized from the fact that the exclusion of the upland runoff from the bottoms or the detention of such runoff until the bottoms runoff has been evacuated would have a favorable effect on many areas which are not subject to direct overflow. This would accrue by virtue of reduced infiltration into the closed sewer systems and by reason of the improved outlet condition into the trunk drainage facilities for the numerous tributary drainage ditches, tiles, and storm sewers which would result from the lower stages in the main drainage channels, both of which effects are much more far-reaching than is generally realized."

"Possibly the most important benefit to be realized, although not so readily apparent as that resulting from the prevention of

direct overflow, would be the general enhancement of land values within the area by virtue of the provision of improved drainage and the elimination of the flood hazard. Statistics bear out the fact that the Illinois section of the St. Louis Metropolitan area has already attracted the major share of the heavy industry of the region by reason of its favorable topography and excellent transportation facilities. There are, at present, large areas of land in the bottoms area which, when properly drained and protected against flooding, would be eminently suitable for either residential or industrial development from the standpoints of topography, railroad and highway facilities and water supply. The steady growth of development, in the face of the existing flood and drainage problems, will serve to point out the desirability of the area for industrial purposes and to give some idea of the increased rate of development which may be expected to occur under improved conditions."

"Another benefit would be the elimination of most of the health hazard which now results from the direct overflow of large residential areas and the flooding of sewers. Other favorable effects of the proposed improvement would be to decrease somewhat the length of the existing south flank levee of the East Side Levee and Sanitary District and to lower to some degree the flood stages in the Prairie du Pont Floodway, both of which items would reduce the hazard of levee failure."

"Important benefits would accrue to the recreational facilities of the area. The provision of a control for the existing McDonough Lake would stabilize the water level, thus providing for better rec-

reational use. The detention of the runoff of the upland streams from Little Canteen Creek to Judy's Branch, both inclusive, in the McDonough Lake Reservoir would reduce the range of fluctuation of water levels in Horseshoe Lake and thereby promote the usage of that lake for fishing and boating. The plan would also eliminate the flows of Little Canteen and Schoenberger Creeks from the lakes in the Grand Marais State Park, which have experienced serious sedimentation and flooding from these streams in the past." (Illinois, 1950, 61-63).

Finally, it is interesting to note some items that are missing in the State report. Horseshoe Lake for example is not discussed, perhaps because it is or will become storage for other segments of the CCDA and also because the focus was on the hillside. In addition, almost the sole concern is with structural measures of control. Thirdly, environmental elements receive just a few brief comments, most of which had to do with fishing and recreation. Fourthly, no map of the area that is flooded is included. The plan has not been implemented.

U.S. Army Corps of Engineers Plan of 1964

In 1957, the U.S. Army Corps of Engineers became the fourth group to study the drainage problem in the CCDA and the entire American Bottoms when a Congressional resolution authorized a drainage study of the American Bottoms. As has been discussed previously in this review, the Corps has been involved in providing flood protection from the Mississippi River through levee improvement projects under the authority of the Flood Control Act of 1936 for some time, but this 1957 Congressional action moved it into the interior flood

control as well.

The authorized Corps study of the interior flooding in the American Bottoms was completed in November 1962, revised in April 1963, and printed in 1964 as House Document No. 329 of the 88th Congress, Second Session. The "purpose of the report was to determine the engineering and economic feasibility of improvements to minimize interior flooding in the area of East St. Louis and vicinity." (Corps, 1964, 18).

The report noted that portions of the area were subject to interior flooding and cited the storms of 1946, 1957, and 1961, when rain of an average depth of fifteen and one-tenth inches (1946), eight and two-tenths (1957), and eight and one-tenth inches (1961) fell in the Bottoms (Corps, 1964, 36). The 1946 storm, of course, has previously been reviewed in depth in this document. The storms "produced excessive runoff which could not be handled by the existing drainage facilities, and large areas of bottomland were flooded. Hillside runoff from the various watercourses spread over the bottomlands and there was extensive flooding of agricultural lands in the eastern and northeastern parts of the area. Areas along County Ditch, Canal No. 1, and in the vicinity of Horseshoe Lake and McDonough Lake were inundated. Residential areas along Illinois State Highway 111, Federal Highways 40 and 66, and the Village of Fairmont City experienced damages. The southern part of the area which included Caseyville, Washington Park, Rosemont, Alorton, Centreville, and Cahokia was overflowed. Grand Marais Lake and State Park and outlying portions of the City of East St. Louis were also flooded." (Corps,

1964, 41-42). The average annual damage has been estimated by the Corps at $267,400 (Corps, 1964, 11-12).

Five basic methods, either singly or in combination, were studied as ways of eliminating or at least reducing the interior flood problem. They were: 1) enlarge and extend the existing drainage system, 2) construct hillside reservoirs, 3) divert hillside runoff, 4) provide detention areas in the bottomlands, and 5) install additional pumping stations (Corps, 1964, 12).

The report also considered the effectiveness of the previous plans. In regards to the feasibility of the 1946 Engineers Committee primary proposal, "studies were made to determine the feasibility of diverting additional hill land runoff behind the flank levees of the Prairie du Pont Creek and Cahokia Creek Diversion Channel, thereby, reducing the required channel enlargement and pumping station requirements. It was concluded that a large diversion channel with high levees would be required. Also, a large number of homes are located along the bluff line making the cost of rights-of-way prohibitive. Therefore, it is not considered feasible to divert runoff when compared to other remedial measures." (Corps, 1964, 108).

The 1950 State of Illinois plan was also investigated, " . . . and as present costs are substantially more than 1950 costs, it was not considered economically feasible. In addition, a number of residential subdivisions, commercial establishments, and other improvements have been constructed since 1950 in areas which were selected for the route of the diversion canal. The costs of rights-of-way and damages for improved properties would further increase the costs, so

the proposed project would not be economically feasible at this time." (Corps, 1964, 108).

Federal action has continued on this American Bottoms interior drainage project since the release of the Corps report in 1964. The improvements recommended in the survey report were authorized in the Federal Flood Control Act of 1965 and funding for advanced engineering, design, and construction has been included in annual Federal public works appropriations since fiscal year 1970 (SIMAPC, 1975, 12). An abbreviated re-study of the authorized plan was completed by the District in December, 1969. The report concluded that the Blue Waters Ditch drainage segment of the American Bottoms would be the desirable first element and that detailed work on the Upper Harding Combined Area and then the Cahokia Canal Drainage Area would follow. A General Design Memorandum No. 1 for the Blue Waters Ditch area improvement has been completed and construction may start soon. Work also has begun on the General Design Memorandum for the Upper Harding Combined Area (SIMAPC, 1975, 12). The Environmental Inventory for the Cahokia Canal Drainage Area is, of course, also a reality.

In regards to the CCDA specifically, the Corps report concluded that interior flooding clearly was a problem in this segment of the American Bottoms. In the Cahokia Canal area of 75,333 acres, the average annual area flooded by non-coincidental rainfall runoff amounts to 4,780 acres, of which 960 are non-productive, 3,580 are agricultural, and 240 acres are urban. The maximum areas flooded once in a fifty year period can be expected to equal or exceed 12,395 acres (Figure I-10). The average annual flood damages in the CCDA

were estimated to be $287,600, with agriculture accounting for $118,000 of this, residential $159,000, and miscellaneous $10,600 (Corps, 1964, 43).

To meet the obvious drainage need in the CCDA, the Corps proposed a plan composed of three detention areas totaling 1,700 acres, the use of Horseshoe Lake as a detention area, the improvement of eleven and seven-tenths miles of channels, the construction of one and six-tenths miles of new channels, and other minor improvements (Corps, 1964, 12-13) (Figure I-11). But the report also stated that " . . . all interior flood damage cannot be economically eliminated." (Corps, 1964, 50). "The only plan which could be economically justified would be limited to providing facilities capable of containing the runoff from a fifty year non-coincidental storm." (Corps, 1964, 73). A fifty year storm is equivalent to a runoff of five and four-tenths inches from the area in fourteen hours (Corps, 1964, 52).

The specific features of the Corps plan for the Cahokia Canal Drainage Area are as follows (Corps, 1964, 53-57):

<u>Detention Areas</u>

1. Upper Cahokia Canal Detention Area. This area, which would receive the flow from a new Upper Cahokia Canal and Long Lake Ditch, would occupy approximately 500 acres of low ground and would provide a total of 1,650 acre feet of storage at elevation 411.0. Flow from the area would be to Horseshoe Lake. A perimeter levee would tie into elevation 413.0 feet.

2. McDonough Lake Detention Area. This area uses 400 acres to provide 1,700 acre-feet of storage. A perimeter levee is tied to

higher ground at elevation 420 feet. The outlet ditch is a new channel from the western end of the present lake to Cahokia Canal, a distance of 1,500 feet.

3. Canteen Creek Detention Area. This is an approximately 800 acre area between Schoolhouse Branch and Canteen Creek that would provide 6,300 acre-feet of storage. A perimeter levee is to be tied to high ground at elevation 420 feet. The flow from the detention area would be into the existing Cahokia Canal.

4. Horseshoe Lake Detention Area. The lake has approximately 2,030 acres of water surface at elevation 403.7 feet, which is the crest of the existing control structure. Twelve thousand two hundred acre-feet of run-off will be stored in the lake with a maximum water surface elevation of 407.6 feet with the non-coincidental fifty year design storm. The lake and surrounding area comprise 4,530 acres at elevation 408 feet. With Granite City Steel Company using part of the lake, the elevation for the non-coincidental design storm would be 408 feet. "For a fifty year frequency coincidental storm, the water surface elevation would be a maximum of 407.7 feet for as much as forty hours." (Corps, 1964, 55).

Channel Improvements

5. County Ditch. Improve 8,750 feet from old U.S. Highway 66 to Illinois Highway 162.

6. Judy's Branch. Improve and widen present channel and raise side levees from Illinois Highway 157 to present Cahokia Canal, a distance of 7,000 feet.

7. Burdick Branch. Improve and widen present channel and raise

existing levees from Illinois Highway 157 to Cahokia Canal, a distance of 7,100 feet. The flow from this channel would be directed southward into a new channel to the present Cahokia Canal.

8. Schoolhouse Branch. Improve present channel and raise levee from Highway 157 to existing Cahokia Canal, a distance of about 9,000 feet.

9. Canteen Creek. Improve and widen present channel and raise side levees from Highway 157 at the bluffs to Black Lane, a distance of about 19,500 feet.

New Channels

10. Upper Cahokia Canal. Construct a new canal to divert the flow from County Ditch and Judy's Branch into the proposed Upper Cahokia Canal Detention Area. The new canal will be about 5,800 feet long.

11. Revised Cahokia Canal. Construct a new Cahokia Canal from the entrance of Burdick Branch south for a distance of about 3,000 feet until it connects with the existing canal.

Other

12. Highway 111 Structure. A new ten foot diameter corrugated metal pipe culvert approximately one hundred feet in length installed adjacent to the existing pipe culvert under Highway 111 to interconnect upper Cahokia Canal detention area and Horseshoe Lake.

13. Granite City Road Structure. This is a new ten foot diameter corrugated metal pipe culvert approximately ninety-five feet in length, installed adjacent to the existing pipe almost under the road and will provide adequate flow capacity between the upper Cahokia Canal detention area and Horseshoe Lake.

14. Hadley Road Highway Bridge. This will be across Cahokia Canal north of the Illinois Terminal Railroad to replace the present structure which has inadequate openings.

The estimated first cost of the project in the Cahokia Canal Drainage Area is $2,700,000 (Table I-9). Over two thirds of the cost is projected to be non-federal, with nearly all of this being rights-of-way, lands and damages. The federal costs including construction, are less than $1,000,000. The substantial non-federal share is an important element in the implementation of this plan. To date, this implementation has not taken place.

The Corps report is a very complete one, but there is one aspect that it does not answer, namely exactly how many net acres of land will be protected by the proposed project (Table I-10). A review of tables B-1 and B-2 in the Corps document suggests that 3,263 acres might be protected with the improvements during a five year storm, 2,761 acres during a ten year storm, and 4,036 during a fifty year storm. This information is valuable, but it would <u>seem</u> desirable to attempt to come up with a net figure, which would <u>seem</u> to result from the subtraction of the proposed impoundment areas from the gross protection figure. Using this assumption, the net protected area becomes 1,563 acres with the five year storm, 1,061 acres with the ten year storm, and 2,336 acres with the fifty year storm. An additional revision is to subtract from the areas protected the additional land around Horseshoe Lake that is used as an impoundment area. Horseshoe Lake with the fifty year storm is projected to have a surface area of 4,018 acres; its normal surface area is 2,030 acres, meaning that 1,988

Table I-9

Estimates of First Costs, Cahokia Canal Drainage Area, Corps Plan

FEDERAL COSTS		$ 870,000
channels and canals	$ 470,000	
floodway control and diversion structures	287,000	
engineering and design	60,000	
supervision and administration	53,000	
NON-FEDERAL COSTS		1,830,000
rights-of-way, lands, and damages	1,720,000	
roads and bridges	91,000	
engineering and design	9,000	
supervision and administration	10,000	
GRAND TOTAL		2,700,000

after Corps, 1964, page 63

Table I-10

Areas Subject to Damage, Cahokia Canal, Corps Plan

Area	5 Year Storm		10 Year Storm		50 Year Storm	
	without improvements	with improvements	without improvements	with improvements	without improvements	with improvements
Agriculture	3,895	773	4,657	1,048	6,144	2,339
Developed	475	303	524	348	676	536
Non-productive	567	598	686	662	1,041	950
Total	4,937	1,674	5,867	3,106	7,861	3,825
New area protected		3,263		2,761		4,036
New impoundment (Total)		1,700*		1,700*		1,700*
McDonough		400		400		400
Canteen		800		800		800
Upper Cahokia		500		500		500
Revised total I		3,374		4,806		5,525
Revised protected I (Net)		1,563		1,061		2,336
Revised II, Horseshoe additional acres		no data		no data		1,988
Revised protected II (Net)		no data		no data		348

*Excludes additional land acquired for storm storage around Horseshoe. While all of the 1,700 acres may not be used with a given storm, this is the amount of land which is reserved for this use and which is thereby taken out of the uses described.

Adapted from: Corps, 1964, Tables B-1 and B-2, 127, 128.

additional acres are flooded when the lake is used as an impoundment area during this storm. The net acreage protected when the Horseshoe Lake expansion is subtracted becomes 348 acres.

This analysis should by no means be considered "gospel", for it assumes that all the necessary data are available and that none of the areas labeled "agriculture, developed or non-productive" are in the impoundment areas, but the analysis does point out that the amount of NET acres protected is not known and that it might be suprisingly small.

Southwestern Illinois Metropolitan and Regional Planning Commission Plan of 1975

The fifth and most recent plan for the flood problem in the Cahokia Canal Drainage Area was produced by the Southwestern Illinois Metropolitan and Regional Planning Commission (SIMAPC) in 1975. As part of their surface drainage program, whose goal was "to develop plan and implementation strategies for managing storm water runoff and basin drainage in the Southwestern Illinois region that could be applied to the solution of current drainage problems and the prevention of future problems" (SIMAPC, 1975, 2), SIMAPC released a 291 page "Plan for Major Drainage: The American Bottoms and Hillside Drainage Area Planning Basin".

As did the Corps study, this SIMAPC report moved towards a recommended solution to the problem in a very systematic manner. SIMAPC first considered the nature of the area in which the drainage problem existed by reviewing the history of flooding problems and the dimensions and sources of the problems and by describing the physical,

developmental, hydrologic, cultural, and ecological characteristics of the planning area. This was followed by an informative overview with a textbook type review of the possible ways in which drainage problems can be handled, namely by corrective measures such as levees and detention basins, and preventive measures such as zoning ordinances, the National Flood Insurance Program, and drainage organizations.

The SIMAPC report then proceeded to analyze the possible structural components of a drainage flood control plan for the CCDA. Four structural elements were considered — impoundments, channel improvement, new channels, and increased pumping. The structural components that were reviewed are as follows: (SIMAPC, 1975, 96-108)

<u>Impoundments</u>

1. Creation of an Upper Detention Area. This area would be west of the County Ditch and between Interstate 270 and the Chicago and Northwestern Railroad. The construction of a spillway on the west levee of the County Ditch and a 7,000 foot, two foot high berm on the southwestern corner would produce a detention area with a 1,400 acre surface area. The construction cost is estimated at $95,000 while the land cost is estimated at $3,560,000. Under existing conditions, according to the SIMAPC report, local stormwater flows across the area in an uncontrolled manner covering in excess of 2,000 acres. The report also states that spillage from the Canal, under current conditions, does not occur very often.

2. Creation of McDonough Lake Detention Area. This is on the east side of the Cahokia Canal between Burdick and Schoolhouse Branches.

The size of the detention area is dependent on the degree of channel improvement and could range from 610 to 790 acres. Three spillway structures — one each for the three water courses (Judy's Branch, Burdick Branch, and Cahokia Canal) — are proposed. The cost of construction is estimated at $255,000. The 790 acres are valued at $1,580,000.

3. Creation of a Lower Detention Area. This area is east of the confluence of Cahokia Canal and Canteen Creek and north of Interstate 70. This detention area would be the recipient of controlled overbank spillage from Cahokia Canal, Schoolhouse Branch, and Canteen Creek. Total cost of construction is estimated at $340,000. The value of the land is estimated at $1,660,000.

Channel Improvements

4. Cahokia Canal.

4a. 8,000 foot segment from Judy's Branch to the McDonough Lake Detention Area to be upgraded to as-built condition. The estimated cost is $350,000.

4b. entire Cahokia Canal County Ditch (from the Conrail Railroad on the north to Horseshoe Lake control structure on the south) to as-built condition. The proposed rehabilitation's cost is $496,000.

4c. entire Cahokia Canal County Ditch to one hundred year capacity. To accomplish this, the channel would have to be more than doubled in width and increased in depth. The initial cost of this improvement would be approximately $10,861,000.

5. Judy's Branch

5a. entire 7,000 foot length from Illinois Highway 157 to the Cahokia Canal to be upgraded to one hundred year capacity. This is useable only if Cahokia Canal is upgraded to a similar degree. Estimated first cost is $482,000.

5b. just the 4,500 foot segment from Highway 157 to spillway structure at McDonough Lake Detention Area to be upgraded to one hundred year storm capacity. Remaining 2,500 feet is to be left in its existing condition. Estimated cost is $309,000.

5c. along with improving the 4,500 foot segment from Illinois Highway 157 to spillway structure at McDonough Lake Detention Area to one hundred year capacity, upgrade the lower 2,500 feet from the proposed spillway to the Cahokia Canal to an as-built condition. Estimated cost is $394,000.

6. Burdick Branch

6a. entire 7,000 foot length from Highway 157 to Cahokia Canal to be upgraded to one hundred year rainfall event. This change is useful only if Cahokia Canal also is improved to the same level. The estimated cost is $212,000.

6b. 4,500 foot segment from Highway 157 to spillway at McDonough Lake Detention Area to be upgraded to one hundred year capacity. The remaining 2,500 feet is to be rehabilitated to as-built condition. Initial cost is $186,000.

6c. just improve the upper 4,500 feet to one hundred year capacity. Lower 2,500 feet is not to be improved. Cost is estimated at $136,000.

7. Schoolhouse Branch

7a. entire 9,000 foot channel from Highway 157 to Cahokia Canal to be improved to one hundred year capacity. This is useable only if Cahokia Canal is also improved to the one hundred year capacity. Estimated cost is $909,000.

7b. upgrade just first 6,000 feet from Highway 157 to spillway at McDonough Lake to one hundred year capacity. Remaining 3,000 feet rehabilitated to as-built condition. Done only if Cahokia Canal also is improved to as-built condition. Cost is estimated at $737,000.

7c. only upper 6,000 foot segment improved to one hundred year capacity. This is done only if Cahokia Canal is not upgraded to as-built condition. The estimated cost is $606,000.

8. Canteen Creek

8a. entire 17,000 foot length upgraded to as-built condition. Estimated cost is $490,000.

8b. entire 17,000 foot length improved to accomodate one hundred year rainfall event. This would require an increase of channel bottom width of one hundred percent and a depth increase of fifty percent. It is practical only when Cahokia Canal is also upgraded to one hundred year capacity. Estimated cost is $1,619,000.

<u>Channel Construction</u>

9. Granite City East Ditch — Build a new two and one half mile channel form the north shore of Horseshoe Lake northward to a point between Dobrey Slough to the new major channel. Estimated cost is $1,016,000.

Pumping Increase

10. North Pumping Station — Increase the pumping capacity to 2,500 cubic feet per second from the current 1,240 cubic feet per second. The lower end of the Canal is a concrete conduit with a 2,500 cubic feet per second capacity. This new pumping capacity would lower the peak elevation in Horseshoe Lake for the one hundred year storm by six inches. The estimated cost is $6,500,000.

The third step in the SIMAPC planning process was to analyze the twenty useful combinations of the described potential structural measures. The combinations considered are given in Table I-11 (SIMAPC, 1975, B-4).

The fourth step was to select one of the alternatives as "the plan". The chosen alternative (#14) involves the creation of detention areas and associated spillways for controlled spillage, the upgrading of existing channels, and the construction of a new channel in the Granite City area (Figure I-12). The specific structural components of the plan are:

1. Creation of detention areas and associated spillways to one hundred year storm capacity at McDonough Lake (for water from Judy's Branch, Burdick Branch, and the upper reaches of the Cahokia Canal) using 608 acres of land to detain 1,400 acre-feet of storm water and a lower detention area (for water from Canteen Creek and Cahokia Canal) impounding 4,200 acre-feet of water. It is not clear from the SIMAPC report if impoundment levees will be built around the detention areas.

2. Upgrading of the Cahokia Canal County Ditch from the Conrail

Table I-11

ALTERNATE COMPONENTS	COMPONENT COST IN 000.S OF DOLLARS	ALTERNATIVE# 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CA. UPGRADING CAHOKIA CANAL																					
1. 100 YEAR CAP.-PENN CENTRAL TO CONTROL STRUCTURE	10,881	X	X	X	X																
2. FROM PENN CENTRAL RR TO CONTROL STRUCTURE OF HORSESHOE LAKE (AS BUILT)	4,096					X	X	X	X					X	X	X	X				
3. JUDY'S BRANCH SOUTHWARD 8000' (AS BUILT)	350									X	X	X	X					X	X	X	X
CB. UPPER DETENTION AREA	85*					X	X	X	X	X	X	X	X								
CC. MC DONOUGH LAKE DETENTION AREA	252*					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CD. LOWER MCDONOUGH LAKE DETENTION AREA	340*					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CE. CHANNEL IMPROVEMENT - JUDY'S BRANCH																					
1. 100 YEAR CAP.-7000'	482	X	X	X	X																
2. 100 YEAR CAP.-4500' PLUS REHABILITATE 2500'	394					X	X	X	X					X	X	X	X				
3. 100 YEAR CAP.-4500' ONLY	308									X	X	X	X					X	X	X	X
CF. CHANNEL IMPROVEMENT - BURDICK BRANCH																					
1. 100 YEAR CAP.-7000'	212	X	X	X	X																
2. 100 YEAR CAP.-4500' PLUS REHABILITATE 2500'	186					X	X	X	X					X	X	X	X				
3. 100 YEAR CAP.-4500' ONLY	136									X	X	X	X					X	X	X	X
CG. CHANNEL IMPROVEMENT - SCHOOLHOUSE BRANCH																					
1. 100 YEAR CAP.-9000'	909	X	X	X	X																
2. 100 YEAR CAP.-6000' PLUS REHABILITATE 3000'	737					X	X	X	X					X	X	X	X				
3. 100 YEAR CAP.-6000' ONLY	606									X	X	X	X					X	X	X	X
CH. CHANNEL IMPROVEMENT TO CANTEEN CREEK FROM ILLINOIS HIGHWAY 157 TO CAHOKIA CANAL																					
1. 100 YEAR CAP.	1,619	X	X	X	X																
2. REHABILITATE AS BUILT	490					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CI. NEW CHANNEL - GRANITE CITY EAST DITCH	1,016	X	X			X	X			X	X			X	X			X	X		
CJ. NORTH PUMPING STATION ENLARGEMENT - DOUBLE EXISTING TO 2500 CFS	6,500	X		X		X		X		X		X		X		X		X		X	
TOTAL FIRST COST PER ALTERNATE (IN THOUSANDS)		21,580	15,080	20,563	14,083	14,108	7,608	13,093	6,593	10,087	3,587	9,081	2,581	14,014	7,514	12,988	6,488	10,092	3,502	8,986	2,486
ANNUAL DEBT SERVICE (IN THOUSANDS)		1,883	1,316	1,794	1,227	1,230	663	1,141	574	880	313	791	225	1,221	666	1,133	566	879	305	734	216
ANNUAL OPERATION AND MAINTAINENCE (IN THOUSANDS)		707	482	657	412	707	482	657	412	707	482	657	412	707	482	657	412	707	482	657	412
TOTAL ANNUAL COSTS (IN THOUSANDS)		2,590	1,778	2,451	1,639	1,937	1,125	1,798	986	1,587	775	1,448	637	1,928	1,117	1,790	978	1,586	787	1,391	628

*COSTS PRESENTED FOR DETENTION AREAS INCLUDE COSTS FOR SPILLWAY STRUCTURES AND SHORT DIVERSION CHANNELS ONLY. LAND COSTS ARE NOT INCLUDED, BECAUSE SOMETHING LESS THAN ACQUISITION BY FEE SIMPLE MAY BE REQUIRED. CURRENT MARKET VALUES ARE GIVEN FOR CONSIDERATION HOWEVER. THE UPPER DETENTION AREA OF APPROXIMATELY 1900 ACRES IS VALUED AT $3.5 MILLION. THE MCDONOUGH LAKE AREA OF 790 ACRES IS VALUED AT $1.3 MILLION AND THE LOWER DETENTION AREA OF 800 ACRES IS VALUED AT $1.6 MILLION.

Source: SIMAPC, 1975, B-4

Railroad to the Horseshoe Lake control structure to as-built condition.

3. Upgrading of Judy's, Burdick, and Schoolhouse Branches to one hundred year storm capacity from the base of the bluffs at Highway 157 to the control spillways in their levees. The remaining lengths of the branches, from the spillways to Cahokia Canal, are to be upgraded to as-built condition.

4. Upgrading of Canteen Creek to as-built condition. This is the only tributary channel that is not improved to a one hundred year capacity (from the bluff to its proposed impoundment area).

5. Construction of Granite City East Ditch. The estimated initial capital costs of this plan is $10,414,000, of which $7,514,000 is for construction and $2,900,000 is for land. The plan has not been implemented (SIMAPC, 1975, 122-125).

The SIMAPC report concludes with information on " . . . the actions which must be taken by the various concerned levels and agencies of government to assure that the selected structural elements of the major drainage plan as well as recommendation for non-structural measures and necessary studies and plan detailing will be carried out". (SIMAPC, 1975, 129). The implementation chapter "reviewed those units and organizations of government which have plan adoption and plan implementation powers, actions necessary for adoption, and financial and technical assistance programs available to the several levels of government in the implementation of the plan." (SIMAPC, 1975, 129).

The SIMAPC planning process did incorporate some items that were

not included in previous plans. For the first time environmental data were collected and the environmental implications of the projects were presented. How these data were actually used in the analysis of the alternatives and in the decision for the selected alternative (the plan) is not clear, however. The report also discussed at some length the importance of non-structural measures of flood prevention.

Surprisingly, there are a few important things that the plan leaves unanswered. One is what happens to the water, which is planned to move more rapidly, once it reaches the control structure at Horseshoe. Where does the water then go? The impression given is that it goes into Horseshoe, but the channel capacity to Horseshoe Lake itself from the control structure is never discussed. Neither is there much discussion of the impact of the new water on the lake; the data available suggest that the water level will be increased. A second is the degree of protection offered by the proposed as-built condition of some of the channels. Is this a ten year or a fifty year storm capacity? A third is where it floods now. The existence of a flooding problem is the reason for the report, but yet a map showing the extent of the flooded area is not given. A fourth is the impact of the nonstructural control of development upon the need for structural solutions (more is said about this later in this review). A fifth is the source of funds for the proposed structural solutions. The need for an implementation organization is presented, but who will pay to make the ideas a reality is not given. A sixth is the amount of land protected by the structural improvements and

the associated per acre cost: the available data suggest that the land could be purchased at a lower cost than it could be protected (Table I-12). A seventh is who pays for the project.

Dobrey Slough-Nameoki Area Plans

One segment of the CCDA that exemplifies the current drainage problems of the American Bottoms in the minds of many people is the Dobrey Slough-Nameoki area in the northern part of Horseshoe Lake Area. The slough itself is a small cigar-shaped natural low area in the northeastern part of the greater Granite City area (it is not within the municipal limits of Granite City) in which and around which homes have been built. As anyone with even a little knowledge of drainage could predict, water collects in this low area after a rain and if the rain is heavy enough, the runoff floods the homes. Increased urbanization in the drainage area aggravates the problem by producing more homes to damage and by sending even more water into the slough. The flood problem in the slough area is real and is severe, but by no means (thank goodness!) is it typical of urban settlement in the Bottoms. In fact, the slough is one of the poorer physical locations for homes in the greater Granite City area.

Unfortunately, the area is like the CCDA in one sense in that through the years numerous plans to solve its drainage problems have been made and remade. Plans for drainage in the Dobrey Slough-Nameoki area have been proposed in 1943, 1946, 1961, 1972, and 1975. Only the 1946 plan was implemented, and it just dealt with a portion of the entire Dobrey Slough-Nameoki area.

Table I-12

Acreage Protected by SIMAPC Plan of 1975

	Spillage, Northern Area Inundated Area, Acres	McDonough Lake Detention Area	Canteen Creek Detention Area
Existing Conditions	2,314	790	725
Improved Channel Capacity with Controlled Spillage	1,360	608	597
Acreage Protected	954	182	128

Total Acreage Protected: 1,264*

*Additional flooding at Horseshoe Lake, if any, due to the improvements is not subtracted from this figure.

Source: Computed from data in SIMAPC, 1975, Table A-2, page A-19.

The Plan of 1943. In 1943, Horner and Shifrin, Consulting Engineers, prepared for the ESLSD a report which proposed storm water outlet facilities for the Village of Nameoki (which is now part of Granite City) and some of the surrounding area, including Dobrey Slough. They suggested three open channels to carry the runoff from the study area to Horseshoe Lake (Figure 1-13). One channel would run in a general north-south direction just to the east of Nameoki Road and would extend from Pontoon Road to Horseshoe Lake. The other two channels would follow the course of existing sloughs south of Pontoon Road and would extend in a general east-west direction from the existing urban area in Nameoki to Bishop Slough, which is east of the Alton and Southern Railroad and south of Pontoon Road. Under the proposal, the runoff diverted into Bishop Slough would drain naturally from the slough to Horseshoe Lake. The plan also noted the possible location of a future channel through Dobrey Slough from the ICG-N&W Railroads southeastward to Bishop Slough (Horner and Shifrin, 1943, 45-46). The estimated cost of the project was $210,000 (Horner and Shifrin, 1943, 49). Seemingly this cost did not include purchase of the proposed ponding area.

The Plan of 1946. The 1943 channel plan for the greater Nameoki area was never implemented, but rather it was revised in 1946. Horner and Shifrin, in 1946, sent another report to ESLSD in which they suggested a single trunk outlet drainage channel rather than the 1943 three channels (Figure 1-14). The single channel would extend in a general north-south direction from Horseshoe Lake on the south to Amos Avenue in the Maryland Heights subdivision on the north.

A northwest lateral would extend from the channel. " . . . the trunk channel and the northwest lateral are designed to provide the same degree of stormwater drainage service as the three channels proposed in the earlier report . . ." (Horner and Shifrin, 1946, 3).

Under the 1946 plan, runoff in the Nameoki area, which was earlier proposed to drain eastward toward Bishop Slough, was redirected in a general westward direction to the north-south channel (which appeared in both proposals). While this revision seemingly made no difference in drainage results in the Nameoki area itself, it did mean that no provision was made for drainage from Dobrey Slough and from the sloughs south of Pontoon Road and west of the Alton and Southern Railroad. Seemingly this plan was implemented and it became ESLSD project #15.

Because it is an existing channel, the proposed design is worth reviewing. The system was prepared under the assumption that " . . . 850 acres were to remain one hundred percent pervious and 748 acres were ultimately to contain twenty percent of impervious surface. Of the remaining 230 acres, 211.6 acres of potentially industrial property in the southeast corner of Granite City were estimated as ten percent impervious and sixteen and four-tenths acres in the vicinity of the intersection of Pontoon and Nameoki Avenues as thirty-five percent impervious and two and two-tenths acres as thirty percent impervious." (Horner and Shifrin, 1946, 6-7). Moreover, the lower reach of the channel from Twenty-third Street to the outlet was designed to have a capacity of 600 cubic feet per second. The flow line of the channel at the outlet was set at 411.1

which is approximately coincident with the controlled low water elevation of 411.0 at Horseshoe Lake (Horner and Shifrin, 1946, 8). It is not clear, however, if the elevation figures are Memphis datum or not.

The Plan of 1961. In 1961, the local firm of Sheppard, Morgan and Schwaab re-addressed the area which was excluded from the 1946 plan. Their investigation, entitled "A Report on Storm Water Relief Sewers, Granite City, Illinois", dealt mainly with Granite City itself, but it also contained a master plan for the construction of drainage facilities on the fringe of the City. The purpose of the fringe review was to provide " . . . for the orderly development of the area and to prevent the unbalancing of proposed storm water drainage facilities in the city when the annexation of these adjacent areas is considered" (Sheppard, Morgan & Schwaab, 1961, 115). In general, the plan proposed to use open ditches. The limits of the fringe area study were Illinois Highway 162 on the south, Highway 111 on the east, near what is now Interstate 270 on the north, the Chain of Rocks Canal on the west, and the city limits of Granite City on the south and southwest. The area contained 6,650 acres (Figure I-15).

Within this area the ICG and N&W Railroads, which run in a northeast-southwest direction, divide the fringe area into two major drainage areas. One of these is tributary to Long Lake or Horseshoe Lake and the second is tributary to the Chain of Rocks Canal or the Mississippi River. The major drainage problem in both major drainage areas was a generally flat topography with small

differences in elevation between the point at which the rain falls and the point of discharge, which makes it difficult to drain the area.

In the Horseshoe Lake watershed, the plan proposed an open channel from Horseshoe Lake to just north of Dobrey Slough, with a branch channel in Dobrey Slough itself, provided for future storm water pipe crossings under the Alton and Southern Railroad, and suggested the filling of selected areas. The channel would initially be an earthen ditch, which could be widened and paved for increased capacity when additional urban development necessitated the change. The structures under the roadways and railroad would be designed for the ultimate development, however. The main channel was proposed to be thirty-five feet in size at the outlet at Horseshoe Lake and tapering to five feet at the head of the channel (it is not clear from the report and the accompanying map if these are the initial or the ultimate dimensions, but the latter is more logical). The plan assumed that the secondary drainage system would be designed and paid for at the time of its construction by those needing it. Two areas are projected to be filled with material excavated from the channel, one of which is Dobrey Slough.

Three channels were proposed for the northwestern segment of the study area. Two channels would serve the area between the Illinois Terminal Railroad on the west and the ICG and N&W Railroads on the east. Another channel would serve the area between the Illinois Terminal Railroad and the Metro East Sanitary District Levee (Sheppard, Morgan and Schwaab, 1961, 118). The outlet for these drainageways

would be to the north to the U.S. Army Corps of Engineers Pond Area #4, a natural low area that drains into Chouteau Slough.

The cost of these proposed drainage improvements was estimated in 1961 to be $1,481,470. Nearly all of this cost was for construction ($1,183,300) and nearly half of this construction cost was for structures ($495,000) (Sheppard, Morgan and Schwaab, 1961, 120). The study suggested that the ESLSD seemed to be the appropriate agency to finance the stormwater trunk drainage channels, but for ESLSD to do this would require the Illinois General Assembly to increase the district's bonded debt limit from two and one half percent of total assessed valuation because of the little to no district bonding capacity then remaining (Sheppard, Morgan and Schwaab, 1961, 139).

The Plan of 1972. The fourth plan for the Dobrey Slough-Nameoki Area was proposed by the State of Illinois Division of Water Resource Management in 1972 (Figure I-16). This plan proposed to remove flood waters from the Dobrey Slough area by the construction of a reinforced concrete box culvert approximately 9,700 feet long that would extend in a north-south direction from Dobrey Slough to Horseshoe Lake. The culvert would provide an immediate gravity outlet for surface water in the 608 acre Dobrey Slough, the area of maximum urban flood damage (Illinois, 1972, 6). While several connection points were proposed along the length of the channel, the structure as planned was an interceptor and hence just a few connections for local drainage were included in the design. The addition of flows from the Long Lake drainage area was included in the plan, however. The total estimated cost of the box culvert was $4,628,500. The proposed Feder-

al share, under Public Law 99, was $4,255,000. The estimated cost of an alternate earth channel was $3,804,500 (Illinois, 1972, 5). The plan has not been implemented.

The Plan of 1975. The fifth plan is the Granite City East Ditch proposal in the SIMAPC American Bottoms plan. (SIMAPC, 1975, 106, 124). They proposed an approximately two and one half mile channel from a point between Dobrey Slough and Long Lake on the north to Horseshoe Lake on the south. A major branch would be built from the main channel northwesterly through Dobrey Slough itself (Figure I-12). It seems that it would be an earthen ditch. The projected cost is $1,016,000.

Federal Flood Insurance Program

The Congress of the United States has recently expanded its role in the flood protection arena. In addition to using the Corps of Engineers to solve flood problems through the construction of structural levee and drainage improvements, the Congress is now also directing that non-structural controls be used through the National Flood Insurance Program. In 1968 the Congress passed the National Flood Insurance Act and in 1973 the Flood Disaster Protection Act came into being. "The flood insurance program was established to make flood insurance available to cover property losses due to inundation by floodwaters. Insurance is sold to property owners or renters at a subsidized uniform rate after the locality has applied to the Federal Insurance Administration for 'emergency' status. After a detailed flood insurance study has been completed, flood zones have been identified, and the locality has adopted floodplain manage-

ment measures, the locality may enter the 'regular' program under which insurance at actuarial rates may be purchased" (Illinois, 1978). The communities are required to adopt local measures to prevent potentially damageable development from taking place in the floodable areas. If the community enforces the ordinance, the residents of it are eligible to purchase flood insurance. Lending institutions are prohibited from approving mortgages on structures located within a designated flood hazard area, unless the borrower purchases flood insurance (SIMAPC, 1975, 14-15). The program is a potential alternative to structural means of minimizing flood damage in the CCDA.

As is suggested above, a community falls into one of three National Flood Insurance Program (NFIP) categories: 1) not in the NFIP, 2) in the NFIP emergency program, and 3) in the NFIP regular program. The community not in the NFIP and without a flood hazard boundary map has no requirements and no sanctions. Once the flood hazard boundary map has been issued, however, the community has one year to apply for the program, otherwise sanctions are in effect. If the Federal Insurance Administration accepts the community's application, the community enters the emergency program. In this phase the community amends its ordinance as required and a flood insurance study is scheduled. Once the flood insurance study (FIS) is finalized, the community has six months in which to pass a regular program ordinance or be suspended. Once the ordinance is passed, the community enters the regular program.

Two key tools in the NFIP are the flood hazard boundary map

(FHBM) and the flood insurance rate map (FIRM). The boundary map shows the approximate location of the one hundred year flood within the community. No elevation data for the height of flooding are given. The insurance rate map follows careful study of the flood potential in the community and shows flood elevations along with depth of flooding.

The flooding area on the flood hazard boundary maps is included within what is called "zone A". Zone A covers those areas within the city limits that are subject to a one hundred year flood. The Zone A delimitation is done by the federal government using the best available information. All development activities within Zone A are to be regulated under the NFIP. Development is any man-made change to improved or unimproved real estate. Before undertaking development in an "A Zone", a property owner must secure a permit from the responsible local government. The permit will be issued only if the project meets the requirements of the floodplain regulation ordinance of that government or is an agricultural use. The local government may levy a fine and/or obtain a court order to have the owner correct the construction if he builds without a permit or if he does not build according to the approved plans.

A flood insurance study is necessary for the local government to move from the emergency program to the regular program. The flood insurance study identifies areas within the community subject to flooding and determines how often and to what depth they can be expected to flood. The study also serves as a basis for adoption of floodplain management measures. The typical flood insurance study

involves appraising a community's flood problems, estimating flood-flow frequencies, establishing flood elevation profiles, plotting flood boundaries, computing flood hazard factors, and delineating the one hundred year floodplain and floodways. The Federal Insurance Administration arranges for a flood insurance study of a community to be conducted by a federal, state, or local agency or by qualified engineering firms (Illinois, 1978).

The Flood Insurance Study provides a Flood Boundary Floodway map which may show up to six types of floodplain areas. They are:

A-numbered zone floodway: the channel and areas next to the channel needed to carry most of the flood flows.

A-numbered zone fringe: areas outside the floodway where there is little flood flow.

A zone: area where it was not feasible to study and map floodway and fringe.

AO zone: areas subject to ponding or other flooding not caused by channel overflow.

B zone: areas of moderate flood hazard.

C zone: areas of minimal flood hazard. (Illinois, 1978).

All properties or parts of properties in the four types of A zones are subject to regulation (Illinois, 1978).

The goal of flood damage reduction is attempted to be met by creating development activity that is free from damage by a one hundred year flood and by creating development that does not add to the flood problem. The first item is met in two ways. One is by elevating the buildings on fill, stilts, piles, by walls oriented with the flow of floodwaters, or by flow-through crawlspace so that all parts of the building subject to water damage are above the

flood level. The second is by floodproofing. This involves using materials and construction techniques so that the walls are watertight and can withstand water pressures. Floodproofing is only permissible for nonresidential buildings. The second item is met by constructing buildings, fences, elevated roads, or large construction projects so they do not create a new obstruction. Most of the communities in the CCDA are in the program.

Most of the flooding is in Madison County (Figure I-17). How Madison County deals with flooding in the county portion of the CCDA (the area of most of the flooding) is presented in the "A zone" floodplain overlay district of the Madison County zoning ordinance given in the appendix (Madison County, 1978, 2-47 through 2-52). The location of this overlay district is given in Figure I-18. There is a close spatial correlation between this map and the Corps' map of the extent of flooding from the fifty year storm (Figure I-10).

The NFIP, in effect, may be one way of preventing increased urban flood damages in the CCDA and reducing the financial loss from those areas that are floodable, without the construction of drainage structures. While this opportunity exists for the urban segment of the area, the program does not apply to agriculture and the prevention or reduction of agricultural damages. It also presents a cost to the people who experience or may experience flooding in the urban areas. It is, in other words, a flood management tool, not a panacea.

CONCLUDING COMMENTS

Internal Flooding

The flooding problem in the CCDA is an interior one due to the runoff from the upland streams and the lack of surface drainage facilities in the urban portions of the CCDA. The river is not now a major concern for the ESLSD and the Corps of Engineers has built a levee system which has kept the Mississippi Floodwater out of the area since the levees have been built. But no one has solved the interior drainage problem.

A History of Planning

During the last thirty-three years, four interior drainage studies have been performed and four somewhat similar plans to solve or at least reduce the problem have been developed. None of the plans have been implemented, even just in part. The system in operation today with the exception of the Nameoki Ditch and Lansdowne Ditch is basically the interior drainage system that was in place over fifty years ago.

Similar Plans

All of the plans attempt to solve the interior drainage problems by structural means. Only the recent NFIP offers a non-structural solution. Moreover, the majority of the plans propose just a modification of the existing structural drainage system. Three of them propose the improvement of existing natural impoundment areas, mainly McDonough Lake, Canteen Creek, and Horseshoe Lake, and the improvement of the existing drainage channels. Just one plan (1946) proposed a major new diversion channel and just one other plan (1950) proposed

an increase in the North Pumping Station. In addition, two proposed channel improvements and just one proposed a new diversion channel.

Few Plans Deal with the Benefit/Cost Relationship

The benefits of the plans are carefully considered in just one of the four. Most of the plans comment upon the usefulness of the proposed improvement, but just one of them (the Corps 1964 study) compares the costs and the benefits.

Extent of Flooding Poorly Known

Though there are several reports on the hydrology of the Bottoms and the CCDA segment of it, the knowledge of the location of the flooded area is extremely limited. The only map in existence is that in the Corps 1964 report and the spatial extent of some of the ponding areas is even questionable in this one. The important floodplain insurance rate map (FIRM) for the Madison and St. Clair County segment of the CCDA has not been produced and the FHBM for the unincorporated areas is at best a good guess of the extent of flooding.

Limited Area Affected Upland Water

Only portions of the area are affected by the hillside runoff. The Chouteau, Nameoki, and Venice levee district area and the urban area of the CCDA are not affected at all, while the area tributary to Horseshoe Lake, including most of the eastern greater Granite City area, is only indirectly affected through the amount of hillside runoff diverted into Horseshoe Lake itself.

Limited Acreage Protected

The acreage protected by the proposed structural improvements may be rather small and, based on the cost of these improvements, the

cost per acre protected may be high. In fact, it might be cheaper to buy all the to-be-protected land and let it flood. Additional engineering studies are needed to discover the actual acreage that would be protected. Further research into how the land could be purchased and how it could be managed are also in order.

NFIP

The National Floodplain Insurance Program adds a new and important element to planning for flooding in the CCDA. Up to just recently, the thrust of the public sector efforts has been to prevent flood damages by directing the water runoff away from people and their improvements. This approach continues, but there is an additional option of directing people away from the areas in which the runoff collects "naturally". Such non-structural means of reducing flood damages would seem to offer substantial potential of reducing damages in the rural segment of the CCDA that is floodable, but there is still a cost for the existing urban dwellers and the farmers.

Local Management and Maintenance

The basic interior flood system seems to be an almost adequate one (if one is able to accept the agricultural flooding and limited urban flooding), but it needs maintenance. There is also a crying need for good management. Perhaps the restructured Metro-East Sanitary District will produce a strong organization that can begin to take care of and manage that which already exists and to plan for the drainage of an urbanizing area, such as in northeastern greater Granite City, before urban flood problems are created.

Environmental Elements

All of the plans to date are engineering plans. The biological and other environmental elements play no significant role in any of them. All of them are examples of pre-NEPA planning and plans.

Sediment

The existing plans are concerned with water control. A new concern, which was introduced in an appendix to the SIMAPC plan, is sedimentation. The upland streams carry more than water and the associated sediment can be and is a problem. This is especially important in the case of Horseshoe Lake, a potentially important park. Almost half of the sediment entering this lake may come from Canteen Creek.

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APPENDIX A

SECTION 218.0 "A ZONE" FLOOD PLAIN OVERLAY DISTRICT

The Flood hazard areas of Madison County, Illinois are subject to periodic inundation which may result in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief, and impariment of the tax base of all of which adversely affect the public hearlth, safety and general welfare. It is the purpose of this zone district to : Restrict or prohibit uses which are dangerous to health, safety or property in times of flood or cause excessive increase in flood heights or velocities, require that uses vulnerable to floods, including public facilities which service such uses, shall be protected against flood damage at the time of initial construction; protect individuals from buying lands which are unsuited for intended uses because of flood hazard,; and comply with the Rules and Regulations of the National Flood Insurance Programs as promulgated by the United States Department of Housing and Urban Development, Federal Insurance Administration as provided in the Rules and Regulations of the Federal Register, Vol. 41 No. 207, Tuesday, October 26, 1976, as amended and which are hereby adopted by rederence and filed in the Office of the County Clerk.

218.1 GENERAL PROVISIONS

218.11 EXISTING ZONE DISTRICTS: All Flood plains in the County are now designated as "A ZONE" zoning districts and it is assumed those district designations will remain unless changed by a zoning admendment. The regulations of this "A ZONE" district apply in addition to existing zoning districts, and to future rezoning concerning any district located in a flood plain. This district is an overlay district and imposes addition requirments to developments proposed in a flood plain.

218.12 MOST RESTRICTIVE: The conditions and restrictions of the A ZONE district shall apply to any special or permitted use by an existing zoning district.

218.13 CONDITIONS OF USE: Conditions of use shall be those applicable to the existing district, those as apply to special uses, and Section 218.0 and all subsections of 218.0, 803.0 and 80[illegible].0.

218.14 FLOOD HAZARD BOUNDARY MAPS: The Flood Hazard Boundary Map No. H-01-47 dated January 31, 1975 and amendments thereto, delineating A Zones as areas that are susceptable to the regulatory flood as prepared by the United States Department of Housing and Urban Development, Federal Insurance Administration is hereby adopted for the purpose of this article and filed as a record in the Office of the County Clerk.

Source: Madison County Zoning Ordinance, as amended June, 1978, B-47 to B-52.

218.5 PERMIT REQUIRED: No person, firm or corporation shall commence any construction, substantial improvement, subdivision of land, placement of a mobile home or other developments in areas located in an A Zone without first obtaining a permit from the Zoning Administrator of Madison County, Illinois. The Zoning Administrator shall not issue such permit for any construction, substantial improvement or other development that does not comply with the provisions of this article or that has been denied a permit required by the Federal or State Law including Section 404 of the Federal Water Pollution Control, Act 1972, 33 U.S.C. 1334

218.6 APPLICATIONS:

(a) Within areas designated as A ZONES each application for development shall be accomied by elevations, in relation to Mean Sea Level, of the lowest habital floor, including basement, and in the case of flood proofed structured, the elevation to which it will be flood proofed.

(b) The Zoning Administrator shall require certification from a registered professional engineer or architect that flood proofing methods are adequate to withstand the flood depths pressured, velocities, impact and uplift forces, and other factors associated with the regulatory flood.

(c) The application shall also contain information or certification as reasonably may be required by the Zoning Administrator in order to determine eligibility for permits or to enfcree the terms of this article.

218.17 REGULATORY FLOOD ELEVATIONS: The County Board shall obtain, review and reasonably utilize Regulatory Flood Elevations data available from Federal, state and/or other sources until such time as such date has been received from the Federal Insurance Administration. Regulatory flood data received from the Federal Insurance Administration shall take precedence over data from other sources.

218.18 WATERCOURSE STANDARDS: The Zoning Administrator shall notify adjacent communities and the Illinois Department of Transporation, Division of Water Resources and the Federal Insurance Administration prior to any alteration or relocation of a watercourse. The flood carrying capacity within the altered or relocated portion of any watercourse shall be maintained.

218.19; REPORTS AND RECORD

(a) The Zoning Administrator shall provide the County Board, the Illinois Department of Transportation, Division of Water Resources and the Federal Insurance Administration with an annual report on forms as provided the County with Federal Insurance Administration.

(b) The Zoning Administrator shall maintain the records of First floor elevations, flood proofing certificates, all varinace documents required by Section 1910.6 (a) (5) and (6) of the Rules and Regulations of the National Flood Insurance Program permit applications, and all other records required by the Federal Insurance Administration.

218.2 NEW CONSTRUCTION AND SUBSTANTIAL IMPROVEMENT STANDARDS:

(a) All new construction and substantial improvements to structures located in an A ZONE shall:

1. Be designed or modified and adequately anchored to prevent flotation, collapse or lateral movement of the structure.

2. Be constructed with materials and utility equipment resistant to flood damage.

3. Be constructed by methods and practices that minimize flood damage to other properties.

4. Have all structural components below the Regulatory Flood Elevation designed to be watertight with walls substantially impermeable to the passage of water and such structural components shall be designed to resist hydrostatic and hydrodynamic loads, and the effect of buoyancy.

(b) 1. The First floor or basement or any structure including residences, to be erected, constructed, reconstructed, altered or moved within an A ZONE district shall be constructed on fill with the finished surface of these floors at or above a point two (2) feet above the regulatory flood elevation or flood profile shown on or attached to the flood plain district map for the particular area. The fill shall be at or above a point one (1) foot above the regulatory flood elevation for the particular area and the fill shall extend at such elevation at least fifteen (15) feet beyond the limit of any structure or building erected thereon. However, no use shall be constructed which will adversely affect the capacity of channels or floodways of any tributary to the main stream, drainage ditch or any other drainage facility or system.

2. Where existing streets or utilities are at elevations which make compliance with Section 218.2 (b) (1) impracticable or in other special circumstances, the Board of Appeals may recommend other flood proofing or building elevation measures in accordance with Section 805.0 (e) in lieu of fill, provided the first flood of the building is at or above a point two (2) feet above the regulatory flood level for the particular area; provided that, no permit under this section shall be issued where the ground adjoining a building or structure designed for human habitation is more than two (2) feet below the regulatory flood elevation or subject to flood velocities greater than four (4) feet per second for the regulatory flood.

(c). Commerical structures within an A ZONE District generally must be constructed on fill with no first floor or basement floors a point two (2) feet above the regulatory flood elevation. Accessory land uses, such as railroad tracks and yards, parking lots may be lower elevations. However, a permit for such facilities to be used by the general public shall not be granted, in the absence of a flood warning system, if the area is inundated to a depth greater than two (2) feet or subject to flood velocities greater than four (4) feet per second upon the occurrence of the regulatory flood.

(d) Manufacturing and industrial buildings, structures, and appurtenant works within an A ZONE district shall be flood proofed in accordance with Section 805.0 (e) to two (2) feet above the regulatory flood elevations. Measures shall be taken to minimize interference with normal plant operations especially for streams having protracted flood durations. Certain accessory lands uses such as yards and parking lots may be at lower elevations subject to requirments set out in Section 804.1.

218.3 MOBILE HOME STANDARDS:

(a) All mobile home parks and mobile home subdivision located in an A ZONE district shall file evacuation plans indicating vehicular access and escape routes, including mobile home hauler routes, with the appropriate diaster preparedness authorities.

(b) All mobile homes to be placed on a site located in an A ZONE district shall:

(1) Have the lowest floor elevated two (2) feet above the Regulatory Flood Elevation.

(11) In the instance of elevation on piling, have all piling foundations placed in stable soil no more than ten (10) feet apart, and reinforcement shall be provided for piers more than six (6) feet above ground.

(111)Have Lots large enough to permit steps to the mobile home, and have adequate surface drainage on all sides of the structure.

(IV) Be placed to prevent flotation, collapse or lateral movement of the structure due to flooding.

(V) Be anchored according to the following specifications:

(a) Over-the-top ties shall be provided at each of the four corner of the mobile home with two additional ties per side at intermediate locations and mobile homes less than fifty (50) feet long shall require one additional tie per side;

(b) Frame ties shall be provided at each corner of the mobile home with five (5) additional ties per side at intermediate points and mobile homes less than fifty (50) feet long shall require four (4) additional ties per side;

(c) All components of the anchoring system shall be capable of carrying four thousand eight hundred (4,800) pounds; and

(d) Any Additions to the mobile home shall be similarly anchored.

218.4 UTILITY STANDARDS:

(a) Public utility facilities, railroad tracks and bridges within an A ZONE District shall be designed to minimize increased in flood elevations and , shall be compatible with any local comprehensive flood plain development plan. Protection to the regulatory flood elevation shall be provided where failure or interruption of these public facilities would result in danger to th public health or safety or where such facilities are essential to the orderly functioning of the area. Where failure or interruption of service would not endanger life or health, a lesser degree of protection may be provided for minor auciliary roads, railroads or utilities.

(b) All new construct and substantial improvements to utilities located in an A ZONE shall provide that:

1. All new and replacement water supply systems shall be designed to minimize or eliminate infiltration of flood waters into the systems. New construction of, or additions and modifications to existing treatment plants shall be flood proofed in accordance with Section 805.0 (e) to a point two (2) feet above the regulatory flood.

2. All new and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of flood waters into the systems and discharges from the systems into the flood waters. Water or sewer systems shall be installed at such elevation as to be compatible with the first flood and basement floor elevations required in Section 218.2 (b) (L).

3. There shall be no disposal of garbage or solid waste materials within flood plain areas except upon issuance of a Special Use Permit at sites approved by the Illinois Environmental Protection Agency and subject to the requirments of Section 218.0. All new and replacement on site waste disposal systems shall be located to aviod impairment to them or contamination from them during flooding.

218.5 STORAGE OR PROCESSING OF MATERIALS: Storage or processing of materials within an A ZONE district that are bouyant, flammable, explosive or in times of flooding could be injurious to human, animals or plant life, shall be at or above a point two (2) feet above the regulatory flood elevation for the particular area or flood proofed to the same level in compliance with conditions attached to Special Use, Section 805.0.

218.6 SUBDIVISION AND OTHER DEVELOPMENT STANDARDS:

All subdivision and other development located in an A ZONE District shall provide that:

(a) All subdivision and other developments proposals shall be designed to minimize flood damage to the proposed subdivision or development site as well as other properties.

(b) All public utilities and facilities such as sewer, gas, electrical and water systems shall be located elevated and constructed to minimize or eliminate flood damage.

(c) Adequate drainage shall be provided so as to reduce exposure to flood hazards.

(d) For any proposed subdivision or new development greater than fifty (50) lots or five (5) acres, whichever is the lesser, the applicant shall show the Regulatory Flood Elevation data for each lot or platted parcel. Provided, that if the Regulatory Flood Elevation data is not available the applicant shall compute and provide this information for each lot or parcel platted greater than fifty (50) lots or five (5) acres, whichever is lesser.

Flood control works within an A ZONE District shall require a Special Use permit and shall comply with applicable Illinois Statutes.

(a) The minimum height and design of any dikes, levees, floodwalls or similar structural works shall be based upon the flood profile of the regional flood confined between the structures subject to the following:

1. For urban areas the minimum height and design of structural works shall be at least three (3) feet above the elevation of the regulatory flood, as confined by structures.

2. Modifications and additions to existing structural works shall assure that the work will provide a means of decreasing the flood damage potential in the area. Any existing structural work which potentially threathens public helath or safety shall be modified or reconstructed in order to meet the standards contained herein within a period of six months of the effective date of this Ordinance.

(b) Flood protection elevations and floodways limits which reflect proposed measures for flood control shall not be effective until such measures are constructed and operative unless the proposal measures will increase flood heights, in which event, the regulatory flood protection elevations and flood plain limits shall reflect the anticipated increases.

(c) Detailed plans shall be submitted to the Land Use committee for any new developments placed on the flood plain landward from dikes, floodwalls, and similar structures. The plans must provide for ponding areas or other measures to protect against flooding from internal drainage or from seep water.

218.8 DISCLAIMER OF LIABILITY: The degree of flood protection required by the Ordinance is considered reasonable for regulatory purposes and is based on engineering and scientific methods of study. Larger floods may occur on rare occasions or the flood heights may be increased by man-made or natural causes. This Ordinance does not imply that development either inside or outside of areas designated as an A ZONE district will be free from flooding or damage. This ordinance does not create liability on the part of the County or any officer or employee thereof for any flood damage that results from reliance on this Ordinance or any administrative decision made lawfully thereunder.

SECTION 3:

That Section 802.9 be added to Article VIII of said Zoning Ordinance to read as follows:

809.2 "A ZONE" Variance Conditions: No A ZONE Variance shall be approved that does not comply with the provisions of Section 1910.6 of the Rules and Regulations of the National Flood Insurance Program.

SECTION 4:

That this Ordinance shall be in full force and effect from and after its passage and approval, as required by law.

Passed by the County Board of the County of Madison, Illinois, on the 18th day of May, 1977, and deposited and filed in the Office of the County Clerk in said County on that date.

Appendix A is a reproduction of Section 218.0 of the Madison County Zoning Ordinance. A review of the material suggests that sections numbered 218.5 and 218.6 on page I-A2 are incorrectly numbered and should be 218.15 and 218.16.

SECTION II

HYDROLOGICAL ELEMENTS

WATER AND SEDIMENT QUALITY

PREPARED BY

JAMIE E. THOMERSON, PH. D.

WATER QUALITY

Introduction

The purposes of the water quality tests are: (1) to provide base line data on water quality in the Chain of Rocks Canal and Cahokia Diversion Channel, (2) to characterize the water in the study area and to offer an explanation for its characteristics, (3) to determine if water quality in the Cahokia Canal Drainage Area is suitable for impoundment in a recreational facility as well as a flood control structure and (4) to determine the quality of the sediments in the streams, ponds and lakes in the study area.

Methods and Materials

Water quality and sediment samples were taken at twenty sites, shown in Figure II-1* and described in Table II-1 during a summer and a winter period of normal flow. Water quality samples were also taken during the peak of a flood period. Samples were collected and processed in the field by Thomerson, Keevin, Ferrari, and Miller. Samples were collected by wading (Sites 1-14) or from a boat in the Chain of Rocks Canal and Cahokia Diversion Channel.

Dissolved Oxygen (DO) and temperature were measured in the field at the time of sample collection with a YSI model 54 ARC meter. Water samples for other parameters were collected and processed in the field as follows: (1) for bacteria determination, water was collected in an eight ounce sterile glass bottle and placed on ice; (2) the following five samples were collected in one liter polyethylene bottles: a) the COD sample received two ml. concentrated sulpheric

*All figures referred to are located in Volume 6 of 6 of this Environmental Inventory Report.

Table II-1

Water and Sediment Quality Sampling Sites

Site 1	Cahokia Canal at Hwy. 50 (Hwy. 3). Below box culvert under Hwy. Just south of National City Police Department and Royal Packing Company. Pig farm just south of canal. Width: 30' to 60'. Steep mud banks, no cover. Usually fairly strong flow. Depth: 2' to 10' plus depending on flow, mud bottom.
Site 2	Cahokia Canal at Hwy. 111 north of Interstate 70. Banks steep, weed and tall grass along banks. Depth: usually 6' plus, width at normal flow: ± 40'. Some logs in channel, usually strong flow.
Site 3	Horseshoe Lake Outfall Canal. North of railroad tracks at Hwy. 111. Flow variable, into or out of lake or none. Collecting site E of Hwy. Bridge canal divided by Island. Depth to 3' at normal flow. Banks not steep, with high grass and weeds. Creeping water primrose and smartweed along margins. Bottom organic-rich mud. Logs and branches in water. Tree cover along south bank to west of highway.
Site 4	Cahokia Canal at Sand Prairie Road north of Interstate 70. Banks steep, some grass and weeds, little marginal vegetation. Bottom slick clay mud. Sample site west of bridge. A few willows along bank, a few sticks and logs in water, flow usually strong. Width at normal flow: 10' to 15', depth: 2' to 3'. Site is above confluence with Canteen Creek.
Site 5	Schoolhouse Branch at Hwy. 157 (old Hwy. 40). Sample site on west side of highway. Rocky riffle at bridge. Sand and mud bottom riffles and pools above bridge. Pools to 5' deep. Banks gradual, open on insides of bends, steep and undercut on outsides. No aquatic vegetation. Large trees and tall weeds along shore. Scattered logs in water and tree roots along undercut banks.
Site 6	Cahokia Canal at railroad bridge near Edelhardt Lake by Collinsville-Granite City road, south of Grey's farm. Steep high banks, sand and mud bottom, 10' plus wide to 2' deep at normal flow. Little flow apparent. Banks with little cover, no aquatic plant. Trees on west bank to south of railroad.

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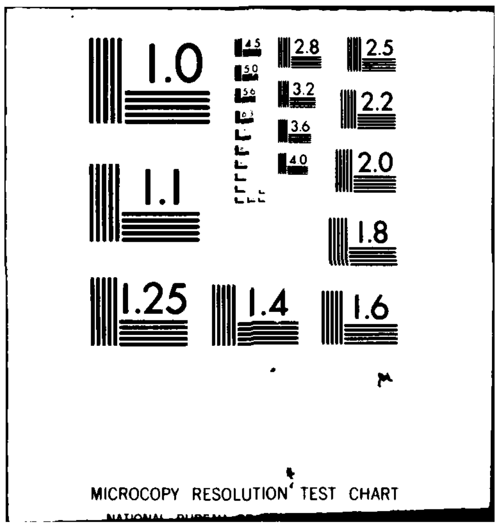
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MICROCOPY RESOLUTION TEST CHART

Table II-1 (con'd)

Site 7	Burdick Branch at Hwy. 157 (old 40). Banks wooded except at highway right-of-way and width up to 10', very shallow, small riffles and pools. No aquatic vegetation, bottom sand, mud and rubble. Some organic debris in water.
Site 8	Judy's Branch at Hwy. 157 (old 40). Very similar to site 7, but up to 15' wide, 1' to 2' deep in pools.
Site 9	Cahokia Canal at Mitchell Road (old Hwy. 40), north of Hwy. 270 and just west of Sand Prairie Road. Width to 50', depth to 3'. Full of logs, old tires, etc., wooded banks, covered with duckweed. Above highway and for 50 to 100 yards below highway, no flow apparent. Bottom organic muck.
Site 10	Mitchell Ditch at Hwy. 162. Due south of Microwave tower, banks open, fields on either side, width to 30'. Pool south of highway then cattails. Hard mud bottom, some algae and creeping water primrose along banks of pool. Channel recently cleared by land owner. Deeper pools with riffles or no flow connecting.
Site 11	Long Lake at Hwy. 111 just south of Pontoon Road. To 200' wide. Depth: to 3'. Soft mud bottom, back yards on shore. Shoreline with trees, various docks, rip-rap, etc. Water fairly clear to turbid, little aquatic vegetation. Many logs and branches on bottom. Sampling site east of Hwy. 111.
Site 12	Moellenbrocks at Elm Slough at Hwy. 111, just north of Collinsville/Granite City Road. Shore open, gently sloping. Marsh to east and west. Water pooled, may be connected with Horseshoe Lake depending on water level. Much creeping water primrose, smartweed and scattered cattail patches. Some duckweed. Depth: to 4', bottom soft organic muck. Water often stagnant.
Site 13	Nameoki Ditch at Hwy. 162. West of railroad tracks. Steep bank with high weeds and grass, no trees. Bottom soft mud to 2' deep, often intermittent, little aquatic vegetation or cover. Blue green algal mats on bottom. Little to no flow under normal conditions.

Site 14 Canteen Creek at USGS gauge at County Road Bridge, 500 feet upstream of Hwy. 157. Bank is steep, densely wooded upstream from the gauge and downstream on the south side. The bank is open about 150' downstream on the north side with tall grass and weeds. There is a low water dam at the gauge. Upstream is a long pool about 20' wide and 1-2 feet deep. The soft bottom is coal chips with some silt and sand. Below the dam is a rocky plunge pool about 30' wide and then rubble riffles and alternately sand, mud and rubble bottomed pools to 4' deep and 40-50 feet wide. There are several large logs and branches. There is a distinct sewage odor and some trash in the creek. The water is fairly clear. The upper pool bottom can be seen.

Site 15 Cahokia Diversion Channel at Old Poag Road. Banks very steep, weeds and grass near Hwy. Trees along channel above and below. Sampling site above Hwy. Depth: to 6', bottom sand and mud. Width: about 80', creeping water primrose and smartweed in patches along shore. Logs and branches common.

Site 16 Cahokia Diversion Channel at Hwy. 111. Banks very steep, heavily wooded, width: about 150', depth: about 2' to 3', bottom mud. Many logs and branches, small patches of creeping water primrose. Open areas of shore with tall grass and weeds.

Site 17 Cahokia Diversion Channel at low water dam. (Sampling site near Hwy. 3). Bank very steep. Width: to 200' depth: 3' to 6'. Mud bottom, some logs and branches in water. Banks wooded.

Site 18 Chain of Rocks Canal at head (near power line crossing). Width: about 400', depth: 9'±. Banks steep, rip-rap. No aquatic vegetation. No noticeable flow. Heavy barge traffic and wave action.

Site 19 Chain of Rocks Canal at middle (below old bridge). Like site 18.

Site 20 Chain of Rocks Canal at mouth (just above Tri-City dock area). (Like site 19).

acid, b) the metals sample received five ml. nitric acid, c) the cyanide sample was adjusted to pH ten with sodium hydroxide, d) the ammonia, nitrate, phosphate sample received a premeasured addition of MgCl and then was placed on ice and e) the alkalinity sample was placed on ice; (3) the phenol sample was collected in a glass liter bottle, the pH adjusted to four with phosphoric acid and a premeasured amount of copper sulphate added; (4) samples for pesticide determination were collected in a glass gallon jar and the mouth covered with aluminum foil before capping; (5) a plastic gallon jar of water was collected for other tests. Sediment samples were collected with a shovel at site 1-14 and with an eckman dredge at sites 15-20. These samples were placed in a widemouth plastic jar. The jar was filled to the brim with sediment and as little water as possible retained in the sample.

On the day of collection, samples were transported to St. Louis Testing Laboratory for determination. Procedures for determination are given in Appendix A. Water quality criteria are those given by USEPA (1976) except as noted. Selected parameters are compared in Table II-2 and test results from St. Louis Testing Laboratory are given in Appendix B.

Relationships Between Sampling Sites and Wastewater Outfalls

Aquatic sampling sites are described in Table II-1. Sites 15 through 17 are on the Cahokia Diversion Channel which serves to route water from Cahokia and Indian creeks directly west to the Mississippi as shown in Figure II-1. The diversion channel receives sewage outfall from the Edwardsville municipal sewage plant and

Table II-2

COMPARISON OF SELECTED WATER QUALITY PARAMETERS

Site	Iron mg/l			Copper mg/l			Mercury mg/l			Alkalinity mg/l			Ammonia (N) mg/l			Phosphates mg/l		
#	N_1	N_2	F	N_1*	N_2	F	N_1**	N_2	F**	N_1	N_2	F	N_1	N_2	F	N_1	N_2	F
1	16.0	2.9	5.1		<.01	.018		7.0		298	195	148	.27	1.5	1.8	3.3	1.6	3.3
2	2.2	.96	8.6		.01	.013		1.0		247	162	169	.42	1.4	1.1	8.4	1.6	1.8
3	2.0	.17	.81		<.01	<.01		<0.5		85	123	117	.28	.81	.38	2.2	.05	1.5
4	3.9	1.9	3.8		.01	.016		2.0		344	286	109	.17	.42	.39	2.9	1.3	2.0
5	.6	2.0	8.6		<.01	.034		2.5		253	304	109	.18	.37	.65	2.6	.95	2.5
6	1.7	1.1	2.9		.01	.042		2.0		325	252	170	.13	.66	.89	2.4	.32	3.4
7	.2	.23	2.1		<.01	.014		<0.5		350	310	170	.17	.18	.45	2.2	1.0	4.4
8	.3	2.5	3.7		.13	.013		1.0		255	269	84	.30	.38	1.5	7.3	.70	2.2
9	2.2	1.3	5.1		.01	.015		<0.5		245	116	178	.65	3.7	.38	8.4	12.0	2.2
10	.6	.24	.58		<.01	.016		<0.5		230	78	54	.24	1.8	2.2	3.0	1.8	2.6
11	1.6	.56	1.2		<.01	.01		<0.5		131	141	119	.11	.21	.25	.75	.25	1.3
12	1.6	.42	1.7		<.01	.015		2.5		258	113	100	.87	.16	.27	1.9	1.0	2.7
13	2.4	1.7	.88		<.01	.01		9.0		210	120	27	.16	.57	.22	1.8	6.9	2.0
14	.45	4.7	45.0		<.01	.048		1.5		138	213	1	.25	.64	3.8	7.8	1.3	1.2
15	.39	.45	1.9		<.01	.013		<0.5		269	200	237	.11	1.28	4.2	4.0	2.9	9.5
16	.6	.39	1.7		<.01	.011		<0.5		242	204	253	<.10	1.4	3.2	.68	2.7	7.5
17	.9	.74	1.2		.09	.014		<0.5		186	202	243	<.10	1.6	.23	.38	2.9	1.2
18	1.2	3.4	1.4		.02	.01		<0.5		162	194	146	<.13	.54	.12	1.3	1.3	1.8
19	1.2	4.2	1.7		<.01	.011		<0.5		167	187	151	.22	.28	.17	.75	1.9	.95
20	7.0	3.8	2.8		.04	.014		<0.5		177	197	153	.14	.25	.32	.83	1.1	1.1

*All sites less than .01 mg/l

**All sites less than .5 mg/l

Southern Illinois University at Edwardsville sewage plant at its upper end and from the South Roxana sewage treatment plant near its middle.

Sites 18 through 20, in an area of barge passage around the Chain of Rocks rapids in the Mississippi River, are on the east side of the Chain of Rocks Canal as shown in Figure II-1. This canal receives outfall from Sunny Shores Mobile Home Park, Highlander Mobile Home Park, Edwards Mobile Home Park, and Granite City sewage treatment plant (SIMAPC, 1978, Figure 36).

Sites 1-14 are in the Cahokia Canal Drainage Area as shown in Figure II-1 and their relationships in terms of sequence of water flow and position of outfalls are explained below. In general, these sites fall into two overlapping categories; those which are in water bodies drained by the Cahokia Canal itself and those which drain into Horseshoe Lake.

Site 9 is the uppermost site on Cahokia Canal. It receives surface waters from the northern portion of the basin; both upland water from north of the Glen Carbon - Edwardsville Road and flood-plain water from the northern part of the basin. SIMAPC (1978, Figure 36) lists the SIUE Service Building, Sunset Hills Country Club, Greenboro Mobile Home Park and Edwardsville PWS as draining into the canal in the vicinity of site 9.

Below site 9 the Cahokia Canal is joined by Judy's Branch (site 8) and Burdick Branch (site 7) which drain the uplands to the east on either side of Hwy. 162 (old Hwy 40). Judy's Branch receives sewage from Bethel Ranch Mobile Home Park, Glen Carbon

Cottonwood, Glen Carbon NE and Glen Carbon W sewage plants, East 30 Mobile Home Park and Glen Carbon PWS. SIMAPC (1978, Figure 36) also shows the Holiday Inn-Edwardsville discharging into Cahokia Canal between Judy's Branch and Burdick Branch. Burdick Branch (site 7) receives sewage from Oliver C. Anderson Hospital and Maryville PWS.

Mitchell Ditch (site 10) drains the northwest corner of the basin and empties into Long Lake not far below site 10. Site 11 is on Long Lake. Long Lake receives sewage from Mitchell School District #9. Long Lake drained into Horseshoe Lake through Elm Slough and the Moellenbrocks (site 12) in the past but now some overflow drains through low-lying areas to Cahokia Canal above site 6. Edelhardt Lake receives waste water from Holiday Mobile Home Park and Arlington Heights Utilities (SIMAPC, 1978, Figure 36) and then drains into Cahokia Canal near site 6.

Schoolhouse Branch (site 5) drains the uplands from Maryville to the northeastern portion of Collinsville. Drainage from McDonough Lake joins Schoolhouse Branch in its lower reaches. In the uplands, Schoolhouse Branch receives waste water from Maryville Colonial Nursing Home and Maryville Highway Police Headquarters (SIMAPC, 1978, Figure 36). The lower portion of Schoolhouse Branch flows through a ditch which joins the Cahokia Canal just below site 6. Canteen Creek (site 14) drains the southeastern portions of the uplands and joins Cahokia Canal just below site 4 on the canal. According to SIMAPC, (1978, Figure 36) the Collinsville sewage treatment plant, Bethel Terrace Mobile Home Park, Burger Chef,

Bo-Jon Motel and Mounds PWS all contribute waste water to Canteen Creek. SIMAPC Figure 36 shows Canteen Creek joining Cahokia Canal below the Horseshoe Lake outfall, but it in fact joins Cahokia Canal just below site 4 far above the outfall canal, as shown in Figure 11-1. The Horseshoe Lake Outfall Canal (site 3) joins the Cahokia Canal about six miles from the Mississippi River. Royal Packing Company and Metro East Sanitary District Lansdowne Plant discharge near site 1.

The major sources of surface water for Horseshoe Lake are industrial waste treatment water from Granite City Steel Company (the major non-flood source), Nameoki Ditch (site 13), which drains a portion of Granite City to the northwest side of the lake; and Elm Slough, which drains into the northeast corner of Horseshoe Lake at Moellenbrocks (site 12). Elm Slough may receive water from Long Lake and Mitchell Ditch. Under flood conditions, the Horseshoe Lake Outfall Canal may carry a major portion of the flow from Cahokia Canal into Horseshoe Lake or under non-flood conditions it may drain Horseshoe Lake into the Cahokia Canal.

Water Quality

Dissolved oxygen (DO) and temperature, as shown in Table 11-3, readings taken during summer low flow were not unusual nor remarkable with the following exceptions:

DO was low at site 4. There was some current and the rusty brown water was turbid. There is spring flow into the canal above this site which explains the low temperture.

DO was high at site 6. This reading was taken in the afternoon

Table 11-3 TIME OF DAY, DO AND TEMPERATURE DATA

Site	Summer Normal (N_1)			Winter Normal (N_2)			Flood (F)		
#	DO/ppm	°C	Time	DO/ppm	°C	Time	DO/ppm	°C	Time
1	7.7	24.7	1530	11.0	5.5	1200	7.7	8.25	1415
2	7.7	23.5	1030	11.2	5.0	1130	10.2	9.0	1400
3	5.7	24.9	1115	12.0	4.0	1045	10.6	8.0	1350
4	3.7	17.5	1045	10.6	5.0	1110	9.7	8.25	1325
5	8.3	23.5	1445	11.8	4.5	1300	9.4	8.5	1450
6	10.3	28.0	1415	11.6	5.0	1325	9.6	8.5	1500
7	2.9	19.25	1130	12.0	3.5	1350	9.8	8.5	1515
8	5.5	19.5	1110	12.4	3.0	0850	10.4	8.25	1520
9	0.3	21.5	1030	3.5	3.0	0800	7.4	8.0	1220
10	3.7-7.0	23.5	1200	11.4	4.0	0825	10.0	9.0	1240
11	8.9	29.0	1245	15.0	4.0	0910	8.2	8.75	1250
12	3.1	27.5	1310	3.5	3.0	0930	5.8	8.0	1300
13	10.3	28.7	1345	7.5	4.0	1015	12.2	9.0	1340
14	5.4	21.0	0930	11.4	5.0	1230	8.6	8.75	1435
15	20+	27.9	1310	-	-	-	5.4	12.0	1720
16	10.4	28.0	1245	-	-	-	11.8	12.0	1450
17	8.2	24.6	1150	-	-	-	15.6	11.0	1530
18	8.4	27.6	1530	-	-	-	11.6	10.5	1600
19	8.4	27.6	1630	-	-	-	10.8	11.0	1630
20	7.4	28.0	1700	-	-	-	10.8	11.0	1700

Summer Dates: sites 1, and 5-13 -- August 21, 1978; other sites -- August 22, 1978
Winter Date: December 19, 1978 (Reliable data were not obtained for sites 15-20)
Flood Dates: sites 1-14 -- November 17, 1978; other sites -- November 15, 1978

and the water was green with an algal surface scum. However, very low night time DO would be expected under these conditions.

Sites 7 and 8 are both shaded and may have some spring flow. There was considerable organic matter at site 7 and a stale odor. Creek chubs were present and active in spite of the low DO.

Site 9 had considerable organic matter present and was covered with duckweed. This combined with the morning sampling time explains the very low DO there.

Site 10 was reduced to a pool in the channel. The low DO (3.7) was recorded in the shade of the culvert.

Considerable organic matter was present at site 12 and the water was dark grey. Some minnows were in obvious distress. There was no flow at the time samples were taken.

DO was high at site 13 (Nameoki Ditch) where pads of blue green algae loaded with O_2 were popping to the surface.

Low DO at site 14 is not unreasonable for the morning. This site is shaded. Something had died upstream and many maggots were floating on the water.

Sites 15, 16 and 17 are in the Diversion Canal. DO was very high at the upper two sites, partially because of time of day, and water at both sites was green and photosynthesis was obviously high. Site 15 was almost algal soup and was hypersaturated with oxygen, off the high range scale on the meter.

Site 20 had lower dissolved oxygen (still high) compared to the other Chain of Rocks Canal sites. There is considerable mixing because of barge wakes and the lower reading probably reflects time

of day rather than real difference in water quality.

Winter DO values are generally near saturation values (thirteen ppm at four degrees centigrade). Oxygen demand by living organisms and non-living chemical reactions would be expected to be from four to six times higher at the summer temperatures than at the winter temperatures. Sites 9 and 12 again show low values as would be expected from the high amount of organic matter present at these sites coupled with the early morning sampling times. Site 13 is below saturation for the same reasons.

Flood values for the Cahokia Canal Drainage Area are generally lower than the winter normal flow values, in part due to the elevated temperatures and reduced solubility of oxygen compared to the winter samples. The site 9 value is higher due to the later time of day and perhaps some flushing action. Site 12 is higher but still low compared to the other sites. The same is true of site 13. The low value for site 15 correlates with an increase in pollution index there and a shift to a human source for the bacteria as shown in Table II-4. The values for sites 16 and 17 are high and probably do not reflect the effects of flood waters. Sites 18-20 were not particularly affected by local flooding and their values probably represent normal winter values.

Contamination of waters with animal and human fecal waste can present a health problem, for a number of pathogenic bacteria are often present in such waste. These pathogens are responsible for diseases including typhoid fever, cholera, paratyphoid fever,

Table II-4 Bacterial Pollution, FC/FS Ratios and Interpretations for Summer, N_1 (8/21, 8/23), Winter, N_2 (12/15) and Flood, F (11/15, 11/17) Samples From Twenty Sites in the Cahokia Drainage Area (1-14), Cahokia Diversion Channel (15-17) and Chain of Rocks Canal (18-20).

Site #	Pollution Index*			FC/FS			Interpretation**		
	N_1	N_2	F	N_1	N_2	F	N_1	N_2	F
1	2	3	2	1.8	0.5	4.4	PH	L	H
2	2	0	2	10.4	~1	1.2	H	M	M
3	1	0	1	0.5	0.5	0.8	PL	L	PL
4	1	2	3	1.4	0.9	0.9	M	PL	PL
5	2	2	3	1.3	5.8	~1	M	H	M
6	1	2	2	0.4	0.8	0.5	L	PL	L
7	1	0	3	0.8	0.2	0.3	PL	L	L
8	3	1	2	4.3	0.1	0.1	H	L	L
9	2	3	2	0.5	0.0	0.0	L	L	L
10	0	0	3	0.0	2.5	0.1	L	PH	L
11	2	2	2	23.6	0.1	1.2	H	L	M
12	1	0	2	1.3	~1	0.2	M	L	L
13	0	1	3	0.1	0.6	0.3	L	L	L
14	3	2	2	0.1	0.5	0.0	L	L	L
15	0	1	2	0.8	2.7	6.9	PL	PH	H
16	0	1	1	0.8	2.7	18.6	PL	PH	H
17	0	1	0	0.4	0.4	3.5	L	L	H
18	2	1	1	0.4	3.1	6.4	L	PH	H
19	0	1	1	0.0	0.2	8.2	L	L	H
20	0	1	1	0.0	0.3	4.0	L	L	H

*0 - meets primary contact standards, 1 - meets secondary contact standards, 2 - within range encountered in unpolluted natural waters, 3 - above range encountered in unpolluted natural waters

**L - livestock source, PL - predominantly livestock, M - mixed source, PH - predominantly human, H - human source

enteric fevers, gastroenteritis, and bacillary dysentary. It is often difficult to accurately assay for the presence of these pathogens, so fecal contamination is best detected by the presence of nonpathogens of the coliform and fecal streptococci groups. Data showing the numbers and ratios of these indicator bacteria are useful in determining the amount and type of fecal contamination.

The Federal Water Quality Administration (FWQA) has published the following criteria for determining fecal pollution of waters:

	(Range per 100 ml)	
Type of Water	Fecal Coliform (FC)	Fecal Streps (FS)
unpolluted, raw, surface	67-6,000	20-10,000
polluted, raw, surface	670-60,000	400-100,000

Illinois Pollution Control Board (1977) standards for primary contact (i.e. swimming) waters allow no more than 100 FC/100 ml, for secondary contact (boating, fishing, wading, etc.), no more than 1000 FC/100 ml. It is quite possible for these standards to be exceeded in unpolluted raw surface waters (see above).

Fecal coliforms and fecal streptococci are restricted groups which only grow in the gut of warm blooded animals and hence are specific indications of fecal contamination from this source. The ratio (FC/FS) of fecal coliforms to fecal streps is a useful indication of the specific source of fecal contamination. Waters containing more FC than FS are most likely to contain fecal waste of human origin, while those having more FS than FC most likely

contain waste of animal (particularly live-stock) origin. The following is used to interpret the specific FC/FS value:

FC/FS	Interpretation
4.0	human waste
2-4	predominantly human waste
1-2	mixed human and livestock
.7-1.0	predominantly livestock waste
.7	livestock waste

Interpretation of FC/FS ratios for all samples is given in Table II-4.

Although only four of the twenty-eight normal flow samples exceed levels of fecal coliforms, or fecal streps, or both, expected in unpolluted raw surface waters, twenty-one of the samples exceed primary contact standards and fourteen exceed secondary contact standards. Effects of human pollution are more noticeable than in flood waters: four samples are human waste contaminated, two predominantly human, and four show mixed human and animal contamination.

In general the upper reaches of the Cahokia Canal, Long Lake, Schoolhouse Branch, Little Canteen Creek and Site 1 show the higher pollution levels. Mitchell Ditch, Burdick Branch, Nameoki Ditch, Elm Slough and the Horseshoe Lake Outfall show the lowest levels. The middle reaches of Cahokia Canal and Judy's Branch are variable. There is some correlation between higher levels of contamination and human sources, but this is not a strong relationship. So far as recreational uses are concerned, these data show that Horseshoe Lake probably has better water quality than the rest of the drainage area. Unfortunately, Long Lake,

which receives considerable recreational use, does not have water which meets even secondary contact standards, nor do these data suggest a single type of source for contamination in Long Lake.

Water quality in the Cahokia Diversion Channel is surprisingly good, meeting primary contact standards in the summer sample and secondary contact standards in the winter sample. The Chain of Rocks Canal met secondary standards in five out of six samples. Both these areas shifted from livestock sources in normal flow sampling periods to human in the flood sampling period. Within the Cahokia Drainage Area, flood water seems more bacteriologically contaminated than normal flow water. The index numbers given in Table II-4 are crudely related to order of magnitude of bacterial pollution. These numbers are generally higher for flood waters than for normal flow water. The sum of these numbers for the fourteen sites is eighteen for either of the normal flow periods, suggesting gross similarity between these periods, however the sum for the flood samples is thirty-one, suggesting that the flood waters are much more contaminated than normal flow waters. Five of the sites have an index of three, that is, either fecal coliforms or fecal streps, or both, are present in numbers greater than found in unpolluted raw surface waters. Only site 1 is clearly suffering from human origin pollution and the major source of pollution in flood waters is of animal origin.

In the upper drainage area the major sources of animal pollution are Mitchell Ditch and Burdick Branch, but these seem to have little effect on overall water quality. Schoolhouse Branch, a mixed

source, appears to lower the water quality in the middle reaches of the Canal but this effect is somewhat offset by better quality water from Little Canteen Creek and Horseshoe Lake so that the water quality in the lower reaches of the Canal is similar to that in the upper reaches. However, the source of contamination shifts toward human in the lower reaches. Water coming out of Horseshoe Lake is of better quality than water entering Horseshoe Lake from Nameoki Ditch or Elm Slough.

In general, flood waters exceed secondary contact standards and do not offer immediate promise as a recreational resource.

Water quality in the Cahokia Diversion Channel is generally better than that in the Cahokia Drainage Area, and improves downstream. Water in the Chain of Rocks Canal met secondary contact standards during the flood sampling period.

Iron criteria for aquatic life is one mg/1. Illinois EPA secondary contact standard is less than two mg/1. Higher levels of iron have little effect in brown or black swamp waters where the iron is complexed with organic compounds. At low pH iron tends to form a brown gel or floc on the bottom which may smother fish eggs and benthic organisms. Iron levels are given in Table II-2. Aquatic life criterion was exceeded in seventeen out of twenty-eight normal flow samples in the Chaokia Drainage Area and in eleven out of fourteen flood water samples. The criterion was exceeded sixteen-fold at site 1 in the summer sample, perhaps from packing plant sewage effluent and forty-five fold at site 14 (Canteen Creek) during flood, perhaps from flushing of iron floc

from old mining operations. High iron content would thus seem to contribute to lowering the diversity of aquatic life found in the Cahokia Drainage Area.

Iron levels were below the aquatic life criterion in the Cahokia Diversion Channel during normal flow but exceeded this criterion during flood. Iron levels exceeded aquatic life criterion in the Chain of Rocks Canal in all samples.

Copper levels were generally low in normal flow samples and somewhat higher in flood samples in the Cahokia Drainage Area, however alkalinity in the area is generally high and this reduces toxicity of copper. One notable exception was the flood sample from site 14. Copper is thus probably not a major hazard to aquatic life in the area. A similar pattern was seen in sites 15-17 and 18-19.

The Federal criterion for mercury for protection of aquatic life is .05 mg/l. The state criterion for secondary contact is .5 mg/l. Analysis was done to detect amounts down to the state criterion. This criterion was not exceeded in either summer normal flow nor flood samples, but was exceeded several times in winter normal flow samples from the Cahokia Drainage Area. Mercury levels were high in the lower reaches of the Cahokia Canal, Burdick Branch, Elm Slough, Nameoki Ditch and Canteen Creek. Values at sites 1 and 13 exceeded the state criterion by more than tenfold. In view of the fact that some species of freshwater fish may rapidly concentrate mercury in excess of 10,000 fold, mercury levels in fishes from the lower canal may

constitute a health hazard. Fishing in the lower reaches of the canal is a common activity. Although the Horseshoe Lake outfall (site 3) did not exceed the state criterion, Nameoki Ditch and Elm Slough directly feed Horseshoe Lake.

The Federal criterion for ammonia is for unionized NH_3 (.020 mg/1). A table (USEPA, 1976, pg. 16) is given for values of total ammonia (NH_4 ion plus NH_3) which result in the presence of NH_3 at criterion levels. In general ammonia is more toxic at higher temperatures and higher pH values than at lower values. The state standard is 2.5 mg/1. Considering pH and temperature, a value of about one mg/1 for the summer sample and about three mg/1 for the winter normal flow and flood samples as given in Table II-2 would be near the USEPA criterion. Ammonia would not seem to be a hazard to aquatic life in the summer sample, and only at site 9 in the winter normal flow sample. Although ammonia values are high in the site 14 sample, the low pH (3.86) would drop the NH_3 levels to a very low value. The upper two Cahokia Diversion Channel flood samples had high enough values that there was probably hazard to aquatic life. In general, ammonia does not seem to be a major pollutant in the study area.

Alkalinity and phosphate are both parameters which affect fertility of water. No real criteria for either are available. Lopinot (1972) surveyed the alkalinity of Illinois surface waters and used the following interpretation of alkalinity values: less than fifty ppm (=mg/1), very soft, low productivity; fifty to 100 ppm, moderately soft, medium productivity for fish life; 100 ppm +,

hard, often highly productive of fish. Most of the samples for the study area fall into the hard range (four are medium hard; two flood samples are soft).

Phosphate is often the limiting nutrient for aquatic plant growth and thus a limiting factor in aquatic productivity. The USEPA suggests that values in excess of 100 mg/l in streams are undesirable and may lead to rapid eutropification. This value is far exceeded in all samples except the winter normal flow samples from Horseshoe Lake outfall (site 3). Although the correlation is not very impressive, there may be some correlation between high bacterial counts as shown in Table II-4 and high phosphate levels. These high levels suggest that the probability of rapid eutropification should be considered in any recreational water use planning in the area.

Amounts of cyanide, nitrate, and phenols fall below criteria levels giving cause for concern. Turbidity and suspended solids values run higher than one would like in both normal and flood samples although the effects of these factors on aquatic life are variable depending on the situation. Excess turbidity may lead to smothering of bottom invertebrates and suspended particles may absorb pesticides and keep them in transport.

Lead has no beneficial effects on aquatic life, and is less soluble in hard than in soft water. The only value of lead greater than .01 mg/l was .23 mg/l recorded in the winter normal flow sample from site 20. This is still below values suggested as hazardous for aquatic life. The health criterion for water supply

sources is .05 mg/1.

Clorinated Hydrocarbons
(mg/1 is the same as mcg/1)

Chemical	Illinois Standard mg/1	FEPA Criterion mg/1
Hept. Epoxide	0.1	0.001*
Aldrin	1.0	0.003**
Heptachlor	0.1	0.001*
Dieldrin	1.0	0.003**
DDE	---	-----***
DDT	50.0	0.001***
Lindane	5.0	0.01
Chlordane	3.0	0.01
Endrin	0.5	0.004
Mirex	---	0.001
Methoxychlor	100.0	0.03
PCB	---	0.001

*Heptachlor Epoxide is a conversion product of Heptachlor, although not explicitly stated the federal criterion is for both added together.

**Dieldrin is a breakdown product of Aldrin. The federal criterion is for both added together.

***DDE is a breakdown product of DDT and presumably the standard for DDT would actually be for DDT + DDE.

The Illinois standards given are 1977 standards for drinking and food processing water sources. The USEPA criterion are 1976 criteria for aquatic life. In general, the USEPA criteria ran 1/100 to 1/1,000 of the Illinois standards. Heptachlor, heptachlor epoxide, aldrin, dieldrin, DDT, DDE, chlordan, and PCB are

persistant and accumulate in aquatic life thousands to millions-fold. They are carcinogens and human exposure should be minimized. Production and use of heptachlor, aldrin, dieldrin, and DDT was suspended by the USEPA in 1975 and it is hoped that their presence in the environment will diminish with time. Lindane and methoxychlor are not as bioaccumulative as the others mentioned above. Mirex and PCB had not been as well studied as the others in 1976 and criteria for them may be too high.

Bioaccumulation of chlorinated hydrocarbons is a particular problem in aquatic ecosystems. They are poorly soluble in water and water concentrations drop rapidly after application. The phenomenon of food chain accumulation is well known and well documented. When amounts of chlorinated hydrocarbons in algae, zooplankton, filterfeeding fish and predator fish are compared, the concentrations increase rapidly, perhaps thousands of times between each link in the food chain.

Chlorinated hydrocarbons are readily soluble in fats and oils and absorb to organic or clay particles in the water or in the sediments. Perhaps less appreciated is the thousands fold concentration by the movement of the chemicals from water into the fats and oils of fishes and other aquatic life. Changes in behavior and reproductive success result from exposure to minute concentrations. Behavioral changes may hasten concentration up the food chain as predators prefer to eat prey which show "odd" behavior. But the strongest biological effect of low doses is on reproductive success. In general when eggs are produced there

is a mobilization of the body's energy reserves (fats or oils). This mobilization may release the chlorinated hydrocarbon into the animal's system in debilitating or even lethal doses. If the chemical stays with the fats and oils, it is likely to end up in the eggs in concentrations which insure that the egg dies or produces a defective offspring.

Although none of the water samples exceed the Illinois standards, the analysis performed was not sensitive enough to say if the federal criteria were met. Chlordane values in particular were high on several occasions in the flood and winter normal flow samples. In view of the agricultural nature of the Cahokia Drainage Area (there is in fact, an agricultural aircraft spray operation at Lakeside Airport) it is likely that federal criteria have been exceeded in the past, if not at present. At a minimum, testing of fish flesh for chlorinated hydrocarbons should be carried out on the fish species commonly caught in the lower canal, Horseshoe Lake and Long Lake.

SEDIMENT QUALITY

Data for sediment samples are given in Table II-5. The major question is whether sediment leaching contributes to degradation of water quality. A secondary question is whether sediment quality is such that it must be considered in terms of disposing of dredge spoil when the canal is cleaned.

In general, high COD levels indicate an admixture of organic material to the bottom sediments. Such an admixture is characteristic of bottom sediments in low-lying marshy areas. Sediment COD's were

Table II-5 COMPARISON OF SELECTED SEDIMENT QUALITY PARAMETERS (mg/l)

SITE #	COD		Copper		Cyanide		Iron	
	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2
1	51	89	.01	<.01	<.05	<.05	1.3	.13
2	31	89	.01	<.01	.18	<.03	.2	.22
3	29	104	.01	<.01	<.05	<.05	.3	1.60
4	22	81	.04	<.01	<.05	<.05	2.7	.39
5	8	65	.02	<.01	<.05	<.05	.4	.29
6	18	169	.02	<.06	<.05	<.01	.3	.24
7	8	88	.02	<.01	<.05	<.01	.3	4.40
8	6	145	.01	<.01	.06	<.01	.6	.26
9	55	101	2.30	<.01	<.05	<.01	3.4	3.40
10	49	89	.03	<.01	<.05	<.01	.8	.31
11	52	48	.01	<.01	.06	<.01	1.3	2.10
12	23	125	.02	<.01	.18	<.01	1.5	.64
13	9	185	.02	<.02	<.05	<.01	.4	3.50
14	12	105	<.01	<.01	.05	<.01	.2	1.10
15	13	144	.03	<.01	<.05	<.01	3.2	1.10
16	28	157	.06	<.01	<.05	<.01	8.6	1.10
17	22	210	.02	<.01	<.05	<.01	2.8	1.10
18	22	218	.04	<.01	.16	<.01	1.3	.64
19	22	259	.03	<.01	<.05	<.01	5.5	2.10
20	14	130	.03	<.01	<.05	<.01	16.00	1.00

lower than water COD's for the summer sample at sites, 1, 3, 6, 13, 15, 16, 17, 18, 19, and 20; about the same at sites 5, 7, and 8; and considerably higher at sites 2, 4, 9, 10, 11, 12, and 14. Although no clear correlation between water DO, COD, and Sediment COD emerges, it seems that sediment leaching at these latter sites may contribute to low DOs. Both sediment and water COD's ran higher in the winter sample. This would be expected as a result of lowered rates of chemical breakdown with lower temperatures. Although there is no clear-cut relationship shown in the study area data, percolation of water through sediments may contribute to lowered DO values.

Copper concentrations in summer samples were highest at site 9, approximately one hundred times Illinois EPA water standards (.02 mg/l). This site had considerable automotive trash and a piece of copper pipe or wire may have been in the sediment sample. Standards were exceeded also at sites 4, 15, 16, 18, 19, and 20 by relatively small amounts (i.e., one and one-half to three times standard). Winter sample copper values in sediments were generally lower than summer values with the exception of site 6 where a value of .06 mg/l (three times the Illinois standard) was recorded. The very high value at site 9 was not repeated but rather was less than .01 mg/l.

Cyanide is a product of many life and industrial processes. It is broken down rapidly and is a nonaccumulative protoplasmic poison which interferes with oxygen metabolism. Actual toxicity is affected by many variables, including pH, iron content, amount

of sunlight, etc. Cyanide has not been reported to have any direct effect on recreational uses of water other than its effects on aquatic life. The USEPA criterion for aquatic life is .005 mg/1, the Illinois general standard is .025 mg/1. Water values were all below .01 mg/1. Summer sediment values were usually below .05 mg/1, the outstanding exception being sites 2, 12, and 18. Winter values for sediments were consistantly lower, usually below .01 mg/1. Cyanide complexes with iron to make a less toxic form, but may be released by the action of sunlight.

Iron levels in both water and sediments were extremely variable and there was little correlation between either summer and winter sediment samples or with the water samples taken with them. The extremely high value at site 20 in the summer sample was not repeated in the winter sample, and the winter values in Cahokia Diversion Channel and Chain of Rocks Canal were consistently lower than for the summer sample. Site 9 had identical iron values of 3.4 mg/1 for both samples, perhaps suggesting considerable binding of iron by organic matter at that site. Iron values for site 3 do not suggest iron bearing sediments moving from Horseshoe Lake into the drainage system.

Mercury values were generally present in below standard amounts in the summer sample with the exception of site 6 where the standard was exceeded about seven fold. In the winter samples all samples were determined to be less than .001 mg/1 for all sites except site 16 which had a value of .0016 mg/1, about three times standard.

Ammonia, nitrate and phosphate values ran higher in winter than in summer as a result of both increased amount of dead material present in the winter and the reduced biological activity with lowered temperatures. Phenol values were uniformly low in all samples.

Results of University of Illinois tests of water and sediments in Horseshoe Lake done under contract to the Illinois Department of Conservation are not yet available.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The Cahokia Diversion Channel was fairly eutrophic. Phosphate and alkalinity levels were quite high. Both phosphate and ammonia values dropped rapidly downstream with flooding. Even though bacterial ratios suggested human contamination during flooding (probably from the bypassing of sewage plants by storm water runoff), coliform numbers exceeded secondary contact values only in the upstream flood sample. There was some low level utilization of the lower part of the channel for swimming and fishing, but use of the channel as a storm water runoff ditch would seem to preclude any extensive recreational development. Bottom sediments were fairly high in copper and iron, with manganese values some two to two and one half times as high as iron values.

The Chain of Rocks Canal had uniformly high DO values and all samples except one met secondary contact standards. Bacterial contamination shifted from primarily livestock to human in the flood sample. The Canal itself is not much affected by the local flood but the shift in contamination source probably reflected

bypassing of flood waters by those treatment plants discharging into the canal. Phosphate and alkalinity values were a little lower than for the rest of the study area, relatively unaffected by the flooding, but still high enough to provide for eutropification. Iron and copper values in water were surprisingly variable and exceeded criteria. Iron and manganese values in sediments were also high and variable.

The Cahokia Canal Drainage Area water quality was not as bad as expected. DO values generally ran low in shaded swampy areas where there was considerable organic matter. Low DO values did not seem to be well correlated with high bacterial levels, nor with human sewage contamination. Locally, for example, at site 4 there was considerable intrusion of spring water, typically low in oxygen, and this may account for much of the flow during low flow periods. Bacterial contamination was generally high and waters of the area offered little promise for recreational development involving swimming. Secondary contact standards were exceeded in almost half the normal flow samples and in all but one flood sample. The Horseshoe Lake outfall had generally the lowest level of bacterial contamination seen. Unfortunately Long Lake, one of the recreationally most promising areas, consistantly exceeded secondary contact levels. Six out of twenty-eight normal flow samples had bacterial populations indicating human or predominantly human sources of contamination but no site was consistant between the two sampling periods. Only site 1 showed human contamination during the flood period. It was surprising that

neither Canteen Creek (site 14) nor Nameoki Ditch (site 13) showed human contamination. The iron criterion for aquatic life was exceeded in seventeen out of twenty-eight normal flow samples and in eleven out of fourteen flood samples. Flood waters from Canteen Creek exceeded the criterion forty-five fold. None of the values for iron at site 3 (Horseshoe outfall) suggest that iron is moving either into or out of Horseshoe Lake. Each set of samples shows higher iron values in Cahokia Canal above and below the outfall than in the outfall itself.

Normal flow water from Canteen Creek is similar to that seen in other areas of the drainage, but floodwaters are strikingly different. They are much softer and higher in iron than any other sample. The low hardness in these flood waters means that the copper toxicity is not reduced as it is in the harder normal flow waters.

Mercury values were high in the Lower Cahokia Canal, Burdick Branch, Elm Slough, Nameoki Ditch and Canteen Creek, particularly during the winter normal flow samples. Although values from the Horseshoe Lake Outfall Canal did not exceed state criteria, both Elm Slough and Nameoki ditch feed directly into Horseshoe Lake. Fishing in the lower reaches of the canal and in Horseshoe Lake is a common recreational activity and testing of the commonly caught fish species for mercury ought to be done before there is additional development of recreational fishing in the area. Horseshoe Lake is also used as a fishing area for wintering bald eagles, a federally endangered species. If Horseshoe Lake fishes are

carrying high mercury loads, it could be a disaster for those eagles that eat them. Sampling results also suggest that fishes from the lower canal, Horseshoe Lake and Long Lake should be tested for chlorinated hydrocarbons.

In general, impoundment of water for recreational purposes would meet with problems of eutropification, high iron and bacterial levels and generally marginal water quality. Development for swimming does not look encouraging. Development of wetland areas for water birds and other wetland plants and animals seems a reasonable possiblity, but these areas are likely to fill with sediment and have problems like those that now plague Horseshoe Lake.

Water and Sediment Quality Literature Cited

Illinois Pollution Control Board Rules and Regulations, Chapter 3: Water Pollution. March 3, 1977. pps. 1-54.

Lopinot, A.C. 1972. Total Alkalinity of Illinois Surface Waters, 1971. Illinois Department of Conservation Special Fisheries Report, Vol. #36. pps. 1-13.

U.S. Environmental Protection Agency. Quality Criteria for Water. July 26, 1976. pps. i-ix, 1-501.

Southwestern Illinois Metropolitan Area Planning Commission. Summary Report of the 208 Water Quality Management Final Draft Area Wide Plan for Madison, St. Clair and Monroe Counties, Illinois. May 1, 1978.

APPENDIX A

Saint Louis Testing Laboratories, Inc.

2810 Clark Avenue
St. Louis, Missouri 63103
314/531-8080

PROCEDURES

COD: Determined by the ferrous iron titration of the hexavalent chromium unreduced in the acid reflux vessel.

METALS: Atomic Absorption Spectrophotometry after appropriate dilution or preconcenttation.

MERCURY: Flameless Atomic Absorption by purging the mercury, reduced after a low temperature acid permanganate digestion through an absorption cell.

ALKALINITY: Titrated with standard acid to methyl orange end point potientiometrically.

CHLORIDE: Determined with chloride sensing ion specific electrode, Orion, following ionic strength adjustment to match standards.

CYANIDE: Pyridine-Barbituric acid colorimetric determination of the hydrogen cyanide distilled in a closed system. Reagents were added to convert possible complex cyanides.

AMMONIA: Determined with Orion gas sensing electrode that measures the pH change caused by the ammonia liberated from alkaline solutions.

NITRATE: Determined by the colorimetric Brucine sulfate method.

PHENOL: By the colorimetric 4 amino antipyrine method following distillation. The color was concentrated by extraction with chloroform.

PHOSPHATE: Colorimetric determination of the heteropoly blue produced by the stannous chloride reduction of the phosphomolybdate formed after acid hydrolysis.

TURBIDITY: Measured with Hach 2100 turbidimeter against latex solutions previously standardized against the formazin primary turbidity standards.

SPECIFIC CONDUCTANCE: Measured with a Yellow Springs Instrument Model 33 conductivity meter with a conductivity probes containing a thermister to allow temperature compensation.

SEDIMENTS: Were determined as filtered water elutriates after fifteen (15) minutes of mechanical shaking.

All procedure can be referenced to the 14th Edition (Standard Methods Etc.)

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Environmental Researchers
of Edwardsville
Invoice No. 79-0514
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BACTERIAL ANALYSIS:

FECAL COLIFORM: Membrane filter technique[1] variable volumes of sample filtered through millipore filter (type HC, 0.45 Micromohls). Filter with retained bacteria is incubated using M-FC Broth medium for 24 hrs. at 44.5°C. Colonies developing blue/green sheen are counted using a stereo dissecting microscope with a fluorescent ikluminator. Results are reported as number of colonies/100 ml volume of sample.

FECAL STREPTOCOCCUS:
Same as Fecal Coliform with the exceptions of KF Agar medium, incubated 48 hrs. at 35°C. Bacteria developing a pink sheen are counted and reported as above.

(1) Standard Methods

CHLORINATED PESTICIDES IN SEDIMENTS:
The chlorinated pesticides are extracted from the sample by an acetonitrilepetroleum ether partitioning. Sample cleanup is performed by a florisil column. Different types of pesticides are taken off the column in fractions which are concentrated prior to injection onto a gas chromatograph.

References: Pesticide Analytical Manual Vol. 1, Sec. 211.13-211,17 212.101-212.136
Official Methods of Analysis of A.O.A.C. (1975) 12th Edition, Method 29.001-29.018, Washington D.C.

CHLORINATED PESTICIDES IN WATER:

The chlorinated pesticides are extracted from the sample with petroleum ether. Sample cleanup is performed by a florisil column. Different types of pesticides are taken off the column in 2 fractions which are concentrated prior to injection onto a liquid-gas chromatograph.

References: Presticide Analytical Manual Vol. 1, Sec. 211.13-211.17, 212.101, 212.136
Varian Series 3700 Gas Chromatrography Manual

Respectfully submitted,

W. Dee Trowbridge

W. Dee Trowbridge
Assistant Director

APPENDIX B

Saint Louis Testing Laboratories, Inc.

2810 Clark Avenue
St. Louis, Missouri 63103
314/531-8080

September 14, 1978
Invoice No. 78-5342
Lab No. 3305

Environmental Researchers of Edwardsville
620 Montclaire
Edwardsville, Ill. 62025

REPORT OF ANALYSIS

MATERIAL: Twenty (20) water samples

TESTS REQUESTED: Chemical analysis

RESULTS:

	#1	#2	#3	#4
Alkalinity as $CaCO_3$, mg/l ---	298	247	85	344
Fecal Streptococci, /100 ml -	600	230	340	140
Fecal Coliform, /100 ml -----	1100	2400	170	200
COD, mg/l ------------------	79	41	74	6
Chloride, mg/l --------------	110	96	210	16
Copper, mg/l ----------------	.017	<.01	<.01	<.01
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	16	2.2	2.0	3.9
Lead, mg/l ------------------	<.01	<.01	<.01	<.01
Magnesium, mg/l -------------	42	35	31	35
Mercury, mg/l ---------------	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l ---------	.27	.42	.28	.17
Nitrate, mg/l ---------------	.45	2.2	.81	.40
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	3.3	8.4	2.2	2.9
Specific Conductance, Micromhos/cm ---------	1030	1030	1090	770
Turbidity, NTU --------------	115	16	43	47
Zinc, mg/l ------------------	.27	.07	.11	.02
Suspended Solids, mg/l ------	381	42	37	25
pH -------------------------	7.59	7.58	7.75	7.41

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	#5	#6	#7	#8
Alkalinity as $CaCO_3$, mg/l ---	253	325	350	255
Fecal Streptococci, /100 ml -	980	990	1260	1600
Fecal Coliform, /100 ml -----	1300	400	1000	6900
COD, mg/l ------------------	5	63	6	6
Chloride, mg/l --------------	67	38	51	146
Copper, mg/l ----------------	<.01	<.01	<.01	< .01
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	.6	1.7	.2	.3
Lead, mg/l ------------------	<.01	<.01	<.01	<.01
Magnesium, mg/l -------------	55	38	41	46
Mercury, mg/l ---------------	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l ---------	.18	.13	.17	.30
Nitrate, mg/l ---------------	.33	.18	.53	2.5
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	2.6	2.4	2.2	7.3
Specific Conductance, Micromhos/cm ---------	1280	578	642	1350
Turbidity, NTU --------------	40	105	14	6
Zinc, mg/l ------------------	.04	.11	.04	.02
Suspended Solids, mg/l ------	15	632	70	28
pH -------------------------	7.80	8.18	7.71	7.71

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	#9	#10	#11	#12
Alkalinity as $CaCO_3$, mg/l ---	245	230	131	258
Fecal Streptococci, /100 ml -	2800	860	140	480
Fecal Coliform, /100 ml -----	1500	<1	3300	600
COD, mg/l ----------------	31	4	25	24
Chloride, mg/l ------------	54	22	28	54
Copper, mg/l --------------	<.01	<.01	<.01	<.01
Cyanide, mg/l -------------	<.01	<.01	<.01	<.01
Iron, mg/l ----------------	2.2	.6	1.6	1.6
Lead, mg/l ----------------	<.01	<.01	<.01	<.01
Magnesium, mg/l -----------	11	19	12	18
Mercury, mg/l -------------	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l -------	.65	.24	.11	.87
Nitrate, mg/l -------------	.20	.20	.18	.35
Phenols, mg/l -------------	<.01	<.01	<.01	<.01
Phosphates, mg/l ----------	8.4	3.0	.75	1.9
Specific Conductance, Micromhos/cm --------	642	642	450	642
Turbidity, NTU ------------	34	38	15	18
Zinc, mg/l ----------------	.04	.04	.05	.07
Suspended Solids, mg/l ------	59	49	36	21
pH ------------------------	7.22	7.72	8.20	7.69

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	#13	#14	#15	#16
Alkalinity as $CaCO_3$, mg/l ---	210	138	269	242
Fecal Streptococci, /100 ml -	120	14200	71	30
Fecal Coliform, /100 ml -----	10	5100	60	24
COD, mg/l ------------------	52	4	36	38
Chloride, mg/l --------------	33	52	44	175
Copper, mg/l ----------------	<.01	<.01	<.01	<.01
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	2.4	.45	.39	.6
Lead, mg/l ------------------	<.01	<.01	<.01	<.01
Magnesium, mg/l -------------	11	36	25	32
Mercury, mg/l ---------------	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l ---------	.16	.25	.11	<.10
Nitrate, mg/l ---------------	.30	.02	.18	.18
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	1.8	7.8	4.0	.68
Specific Conductance, Micromhos/cm ---------	450	1030	770	1090
Turbidity, NTU --------------	25	16	15	14
Zinc, mg/l ------------------	.04	.16	.06	.06
Suspended Solids, mg/l ------	19	40	48	38
pH --------------------------	8.08	7.37	8.79	8.53

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	#17	#18	#19	#20
Alkalinity as $CaCO_3$, mg/l ---	186	162	167	177
Fecal Streptococci, /100 ml -	40	5000	470	890
Fecal Coliform, /100 ml -----	16	2200	<1	<1
COD, mg/l ------------------	34	34	30	35
Chloride, mg/l --------------	62	32	30	26
Copper, mg/l ----------------	<.01	<.01	<.01	<.01
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	.9	1.2	1.2	7.0
Lead, mg/l ------------------	<.01	<.01	<.01	<.01
Magnesium, mg/l -------------	27	20	16	17
Mercury, mg/l ---------------	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l ---------	<.10	<.13	.22	.14
Nitrate, mg/l ---------------	.05	1.1	1.6	1.9
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	.38	1.3	.75	.83
Specific Conductance, Micromhos/cm ---------	770	450	450	450
Turbidity, NTU --------------	11	32	38	64
Zinc, mg/l ------------------	.07	.19	.11	.13
Suspended Solids, mg/l ------	33	137	101	181
pH --------------------------	8.49	8.61	8.47	8.37

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CHLORINATED HYDROCARBONS: (WATER SAMPLES)

SAMPLES: #1, #2, #3, #4, #5, #6, #7, #8, #9, #10, #11
#12, #13, #14, #16, #17, #18, #19

Heptachlor Epoxide ---------	<0.05 mg/l
Aldrin ---------------------	<0.05 mg/l
Heptachlor -----------------	<0.05 mg/l
Dieldrin -------------------	<0.05 mg/l
DDE ------------------------	<0.05 mg/l
DDT ------------------------	<0.10 mg/l
Lindane --------------------	<0.05 mg/l
Chlordane ------------------	<0.3 mg/l
Endrin ---------------------	<0.10 mg/l
Mirex ----------------------	<0.10 mg/l
Methoxychlor ---------------	<0.10 mg/l

Respectfully submitted,

W. Dee Trowbridge

W. Dee Trowbridge
Assistant Director

WDT/kvh

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September 14, 1978
Invoice No. 78-5342
Lab No. 3305

Environmental Researchers of Edwardsville
620 Montclaire
Edwardsville, Ill. 62025

REPORT OF ANALYSIS

MATERIAL: Twenty (20) sediment samples

TESTS REQUESTED: Chemical analysis

RESULTS:

	#1	#2	#3	#4
COD, mg/l -----------	51	31	29	22
Copper, mg/l --------	.01	.01	.01	.04
Cyanide, mg/l -------	<.05	.18	<.05	<.05
Iron, mg/l ----------	1.3	.2	.3	2.7
Lead, mg/l ----------	<.01	<.01	<.01	<.01
Manganese, mg/l -----	.15	.27	.12	1.7
Mercury, mg/l -------	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l -	.88	.20	.36	.42
Nitrate, mg/l -------	.05	.02	.05	.10
Phenols, mg/l -------	<.01	<.01	<.01	<.01
Phosphates, mg/l ----	1.6	1.5	3.3	2.4
Zinc, mg/l ----------	.02	.02	.01	.03

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	#5	#6	#7	#8
COD, mg/l -----------	8	18	8	6
Copper, mg/l --------	.02	.02	.02	.01
Cyanide, mg/l -------	<.05	<.05	<.05	.06
Iron, mg/l ----------	.4	.3	.3	.6
Lead, mg/l ----------	<.01	<.01	<.01	<.01
Manganese, mg/l -----	.04	.08	.17	.08
Mercury, mg/l -------	<.0005	.0034	<.0005	<.0005
Ammonia, as N, mg/l -	.10	.35	.13	.13
Nitrate, mg/l -------	<.01	.02	.13	.18
Phenols, mg/l -------	<.01	<.01	<.01	<.01
Phosphates, mg/l ----	.3	1.6	1.4	1.3
Zinc, mg/l ----------	.01	.02	.02	.01

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	#9	#10	#11	#12
COD, mg/l -----------	55	49	52	23
Copper, mg/l --------	2.3	.03	.01	.02
Cyanide, mg/l -------	<.05	<.05	.06	.18
Iron, mg/l ----------	3.4	.8	1.3	1.5
Lead, mg/l ----------	<.01	<.01	<.01	<.01
Manganese, mg/l -----	2.3	.07	.37	.27
Mercury, mg/l -------	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l -	2.2	.18	.14	.28
Nitrate, mg/l -------	.13	.07	.05	<.01
Phenols, mg/l -------	<.01	<.01	<.01	<.01
Phosphates, mg/l ----	3.6	4.1	1.4	4.2
Zinc, mg/l ----------	.71	.01	.03	.05

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	#13	#14	#15	#16
COD, mg/l	9	12	13	28
Copper, mg/l	.02	<.01	.03	.06
Cyanide, mg/l	<.05	.05	<.05	<.05
Iron, mg/l	.4	.2	3.2	8.6
Lead, mg/l	<.01	<.01	<.01	<.01
Manganese, mg/l	.20	.32	5.4	3.4
Mercury, mg/l	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l	.04	.05	1.3	.60
Nitrate, mg/l	.02	<.01	.20	.10
Phenols, mg/l	<.01	<.01	<.01	<.01
Phosphates, mg/l	7.8	1.3	2.6	3.3
Zinc, mg/l	.02	.02	.03	.11

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	#17	#18	#19	#20
COD, mg/l ------------	22	22	22	14
Copper, mg/l ---------	.02	.04	.03	.03
Cyanide, mg/l --------	<.05	.16	<.05	<.05
Iron, mg/l -----------	2.8	1.3	5.5	16
Lead, mg/l -----------	<.01	<.01	<.01	<.01
Manganese, mg/l ------	4.2	3.9	4.2	1.8
Mercury, mg/l --------	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l -	.56	1.5	.50	.52
Nitrate, mg/l --------	.50	.25	.02	<.01
Phenols, mg/l --------	<.01	<.01	<.01	<.01
Phosphates, mg/l ----	2.0	4.1	4.1	4.3
Zinc, mg/l -----------	.11	.08	.06	.08

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SAMPLES: #2, #5, #9

Heptachlor epoxide ----------	<0.02 ppm
Dieldrin -------------------	<0.02 ppm
DDE -------------------------	<0.02 ppm
DDT -------------------------	<0.02 ppm
Chlordane ------------------	<0.14 ppm
Endrin ----------------------	<0.02 ppm
Mirax -----------------------	<0.02 ppm
Methoxychlor ---------------	<0.02 ppm
Lindane --------------------	*
Heptachlor -----------------	*
Aldrin ----------------------	*

* Cannot quantitate due to interferring peaks.

SAMPLES: #3

Heptachlor epoxide ----------	<0.02 ppm
Dieldrin -------------------	<0.02 ppm
DDE -------------------------	<0.02 ppm
DDT -------------------------	<0.02 ppm
Chlordane ------------------	<0.09 ppm
Endrin ----------------------	<0.02 ppm
Mirex -----------------------	<0.02 ppm
Methoxychlor ---------------	<0.02 ppm
Lindane --------------------	*
Heptachlor -----------------	*
Aldrin ----------------------	*

* Cannot quantitate due to interferring peaks.

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SAMPLES: #6, #7

Heptachlor epoxide ---------	<0.02 ppm
Aldrin --------------------	<0.02 ppm
Heptachlor ----------------	<0.02 ppm
Dieldrin ------------------	<0.02 ppm
DDE -----------------------	<0.02 ppm
DDT -----------------------	<0.02 ppm
Lindane -------------------	<0.02 ppm
Chlordane -----------------	0.02 ppm
Endrin --------------------	<0.02 ppm
Mirex ---------------------	<0.02 ppm
Methoxychlor --------------	<0.02 ppm

SAMPLES: #8

Heptachlor epoxide ---------	<0.02 ppm
Aldrin --------------------	<0.02 ppm
Heptachlor ----------------	<0.02 ppm
Dieldrin ------------------	<0.02 ppm
DDE -----------------------	<0.02 ppm
DDT -----------------------	<0.02 ppm
Lindane -------------------	<0.02 ppm
Chlordane -----------------	0.04 ppm
Endrin --------------------	<0.02 ppm
Mirex ---------------------	<0.02 ppm
Methoxychlor --------------	<0.02 ppm

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SAMPLES: #10

Heptachlor epxoide ----------	<0.02 ppm
Aldrin ---------------------	<0.02 ppm
Heptachlor -----------------	<0.02 ppm
Dieldrin -------------------	<0.02 ppm
DDE ------------------------	<0.02 ppm
DDT ------------------------	<0.02 ppm
Lindane --------------------	<0.02 ppm
Chlordane ------------------	0.03 ppm
Endrin ---------------------	<0.02 ppm
Mirex ----------------------	<0.02 ppm
Methoxychlor ---------------	<0.02 ppm

SAMPLES: #11, #16, #18

Heptachlor epoxide ----------	<0.02 ppm
Aldrin ---------------------	<0.02 ppm
Heptachlor -----------------	<0.02 ppm
Dieldrin -------------------	<0.02 ppm
DDE ------------------------	<0.02 ppm
DDT ------------------------	<0.02 ppm
Lindane --------------------	<0.02 ppm
Chlordane ------------------	<0.02 ppm
Endrin ---------------------	<0.02 ppm
Mirex ----------------------	<0.02 ppm
Methoxychlor ---------------	<0.02 ppm

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SAMPLES: #12

Heptachlor epoxide	<0.02 ppm
Dieldrin	<0.02 ppm
DDE	<0.02 ppm
DDT	<0.02 ppm
Chlordane	<0.06 ppm
Endrin	<0.02 ppm
Mirex	<0.02 ppm
Methoxychlor	<0.02 ppm
Heptachlor	*
Aldrin	*
Lindane	*

* Cannot quantitate due to interferring peaks.

SAMPLES: #13

Heptachlor epoxide	<0.02 ppm
Aldrin	<0.02 ppm
Heptachlor	<0.02 ppm
Dieldrin	<0.02 ppm
DDE	<0.02 ppm
DDT	<0.02 ppm
Lindane	<0.02 ppm
Chlordane	0.10 ppm
Endrin	<0.02 ppm
Mirex	<0.02 ppm
Methoxychlor	<0.02 ppm

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SAMPLES: #1, #14

Heptachlor epoxide ----------	<0.02 ppm
Dieldrin --------------------	<0.02 ppm
DDE -------------------------	<0.02 ppm
DDT -------------------------	<0.02 ppm
Chlordane -------------------	<0.07 ppm
Endrin ----------------------	<0.02 ppm
Mirex -----------------------	<0.02 ppm
Methoxychlor ----------------	<0.02 ppm
Lindane ---------------------	*
Heptachlor ------------------	*
Aldrin ----------------------	*

* Cannot quantitate due to interferring peaks.

SAMPLES: #15

Heptachlor epoxide ----------	<0.02 ppm
Aldrin ----------------------	<0.02 ppm
Heptachlor ------------------	<0.02 ppm
Dieldrin --------------------	0.03 ppm
DDE -------------------------	<0.02 ppm
DDT -------------------------	<0.02 ppm
Lindane ---------------------	<0.02 ppm
Chlordane -------------------	0.10 ppm
Endrin ----------------------	<0.02 ppm
Mirex -----------------------	<0.02 ppm
Methoxychlor ----------------	<0.02 ppm

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SAMPLE: #17

Heptachlor epoxide ------------	<0.02 ppm
Aldrin -----------------------	<0.02 ppm
Heptachlor -------------------	<0.02 ppm
Dieldrin ---------------------	<0.02 ppm
DDE --------------------------	<0.02 ppm
DDT --------------------------	<0.02 ppm
Lindane ----------------------	<0.02 ppm
Chlordane --------------------	<0.07 ppm
Endrin -----------------------	<0.02 ppm
Mirex ------------------------	<0.02 ppm
Methoxychlor -----------------	<0.02 ppm

SAMPLE: #19

Heptachlor Epoxide ------------	<0.02 ppm
Aldrin -----------------------	<0.02 ppm
Heptachlor -------------------	<0.02 ppm
Dieldrin ---------------------	<0.02 ppm
DDE --------------------------	<0.02 ppm
DDT --------------------------	<0.02 ppm
Lindane ----------------------	<0.02 ppm
Chlordane --------------------	<0.03 ppm
Endrin -----------------------	<0.02 ppm
Mirex ------------------------	<0.02 ppm
Methoxychlor -----------------	<0.02 ppm

Respectfully submitted,

W. Dee Trowbridge

W. Dee Trowbridge
Assistant Director

WDT/kvh

Saint Louis Testing Laboratories, Inc.

2810 Clark Avenue
St. Louis, Missouri 63103
314/531-8080

October 6, 1978
Invoice No. 78-5342
Lab No. 3305

Environmental Researchers of Edwardsville
620 Montclaire
Edwardsville, Ill. 62025

REPORT OF ANALYSIS

MATERIAL: Two (2) sediment samples identified #4 & #20

TESTS REQUESTED: Chlorinated Hydrocarbons

RESULTS: *

Heptachlor Epoxide, ppm ----	<.02
Aldrin, ppm ----------------	<.02
Heptachlor, ppm ------------	<.02
Dieldrin, ppm --------------	<.02
DDE, ppm -------------------	<.02
Lindane, ppm ---------------	<.02
Chlordane, ppm -------------	<.02
Endrin, ppm ----------------	<.02
Mirex, ppm -----------------	<.02
Methoxychlor, ppm ----------	<.02

* Identical results for both samples.

Respectfully submitted,

W. Dee Trowbridge
W. Dee Trowbridge
Assistant Director

WDT/kvh

Saint Louis Testing Laboratories, Inc.

2810 Clark Avenue
St. Louis, Missouri 63103
314/531-8080

October 6, 1978
Invoice No. 78-5342
Lab No. 3305

Environmental Researchers of Edwardsville
620 Montclaire
Edwardsville, Ill. 62025

REPORT OF TESTS

MATERIAL: Two (2) water samples identified #15 and #20

TESTS REQUESTED: Chlorinated Hydrocarbons

RESULTS: *

Heptachlor Epoxide, mcg/l ------	<.05
Aldrin, mcg/l ------------------	<.05
Heptachlor, mcg/l --------------	<.05
Dieldrin, mcg/l ----------------	<.05
DDE, mcg/l ---------------------	<.05
DDT, mcg/l ---------------------	<.10
Lindane, mcg/l -----------------	<.05
Chlordane, mcg/l ---------------	0.3
Endrin, mcg/l ------------------	<.10
PCB, mcg/l ---------------------	<.60
Mirex, mcg/l -------------------	<.10
Methoxychlor, mcg/l ------------	<.10

* Identical results for both samples.

Respectfully submitted,

W. Dee Trowbridge
W. Dee Trowbridge
Assistant Director

WDT/kvh

Saint Louis Testing Laboratories, Inc.

2810 Clark Avenue
St. Louis, Missouri 63103
314/531-8080

November 29, 1978
Invoice No. 78-7016
Lab No. 3305

Environmental Researchers of Edwardsville
620 Montclaire
Edwardsville, Ill. 62025

REPORT OF ANALYSIS

MATERIAL: Twenty (20) water samples

(samples labeled N are flood water)

TESTS REQUESTED: Chemical analysis

RESULTS:

	1h	2h	3h	4h	5h
Alkalinity as $CaCO_3$, mg/l ---	148	169	117	109	109
Fecal Streptococci, /100 ml -	2280	2720	420	9480	>20,000*
Fecal Coliform, /100 ml -----	>10,000*	3160	328	8700	>20,000*
COD, mg/l ------------------	314	133	98	84	84
Chloride, mg/l --------------	100	86	27	28	49
Copper, mg/l ----------------	.018	.013	<.01	.016	.034
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	5.1	8.6	.81	3.8	8.6
Lead, mg/l ------------------	<.01	<.01	<.01	<.01	<.01
Magnesium, mg/l -------------	31	.37	30	19	20
Mercury, mg/l ---------------	<.0005	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l ---------	1.8	1.1	.38	.39	.65
Nitrate, mg/l ---------------	.99	1.1	1.0	.80	1.0
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	3.3	1.8	1.5	2.0	2.5
Specific Conductance, Micromhos/cm ---------	998	958	1120	516	639
Turbidity, NTU --------------	110	190	15	100	100
Zinc, mg/l ------------------	.38	.44	.04	.05	.07
Suspended Solids, mg/l ------	449	391	30	201	49
pH --------------------------	7.54	7.88	8.06	7.64	7.54

* Est. (TNTC - Too Numerous to Count)

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Invoice No. 78-7016

	6h	7h	8h	9h	10h
Alkalinity as $CaCO_3$, mg/l ---	170	170	84	178	54
Fecal Streptococci, /100 ml -	4360	>15,000*	5600	2240	>20,000*
Fecal Coliform, /100 ml -----	2220	3740	2600	40 **	1430
COD, mg/l -------------------	48	54	40	32	60
Chloride, mg/l --------------	50	62	27	43	26
Copper, mg/l ----------------	.042	.014	.013	.015	.016
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	2.9	2.1	3.7	5.1	.58
Lead, mg/l ------------------	<.01	<.01	<.01	<.01	<.01
Magnesium mg/l --------------	25	23	23	10	20
Mercury, mg/l ---------------	<.0005	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l ---------	.89	.45	1.5	.38	2.2
Nitrate, mg/l ---------------	.83	.19	.94	.44	1.4
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	3.4	4.4	2.2	2.2	2.6
Specific Conductance, Micromhos/cm ---------	760	560	640	640	1360
Turbidity, NTU --------------	72	93	38	57	8
Zinc, mg/l ------------------	.03	.02	.14	.03	.29
Suspended Solids, mg/l ------	30	199	20	99	10
pH --------------------------	7.83	7.88	7.18	7.46	7.16

* Est. (TNTC)

** Identification questionable due to atypical blue coloration of colonies present.

Saint Louis Testing Laboratories, Inc.

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	11h	12h	13h	14h	15h
Alkalinity as $CaCO_3$, mg/l ---	119	100	27	<1	237
Fecal Streptococci, /100 ml -	3380	2140	>15,000*	1240	780
Fecal Coliform, /100 ml -----	4060	380	5140	28	5360
COD, mg/l ------------------	40	99	30	34	42
Chloride, mg/l --------------	34	163	6.2	94	43
Copper, mg/l ----------------	.010	.015	.010	.048	.013
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	1.2	1.7	.88	45	1.9
Lead, mg/l ------------------	<.01	<.01	<.01	<.01	<.01
Magnesium, mg/l -------------	13	15	1.7	27	24
Mercury, mg/l ---------------	<.0005	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l ---------	.25	.27	.22	3.8	4.2
Nitrate, mg/l ---------------	.48	.80	.63	.91	.93
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	1.3	2.7	2.0	1.2	9.5
Specific Conductance, Micromhos/cm ---------	480	1120	112	1280	1090
Turbidity, NTU --------------	18	10	13	110	30
Zinc, mg/l ------------------	.02	.04	.04	1.1	.02
Suspended Solids, mg/l ------	35	8	8	120	31
pH --------------------------	7.70	7.27	7.66	3.86	7.66

* Est. (TNTC)

Saint Louis Testing Laboratories, Inc.

2810 Clark Avenue
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Environmental Researchers
of Edwardsville
Invoice No. 78-7016

	16h	17h	18h	19h	20h
Alkalinity as $CaCO_3$, mg/l ---	253	243	146	151	153
Fecal Streptococci, /100 ml -	12	4	119	78	124
Fecal Coliform, /100 ml -----	223	14	760	640	500
COD, mg/l -------------------	164	109	71	79	69
Chloride, mg/l --------------	120	146	29	30	30
Copper, mg/l ----------------	.011	.014	<.01	.011	.014
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	1.7	1.2	1.4	1.7	2.8
Lead, mg/l ------------------	<.01	<.01	<.01	<.01	<.01
Magnesium, mg/l -------------	28	27	18	18	18
Mercury, mg/l ---------------	<.0005	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l ---------	3.2	.23	.12	.17	.32
Nitrate, mg/l ---------------	.58	.45	1.4	1.5	1.5
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	7.5	1.2	1.8	.95	1.1
Specific Conductance, Micromhos/cm ---------	1160	1160	594	551	580
Turbidity, NTU --------------	13	15	20	27	38
Zinc, mg/l ------------------	.02	.01	.01	.01	.02
Suspended Solids, mg/l ------	34	19	39	52	66
pH --------------------------	8.00	8.95	8.19	8.15	8.20

Respectfully submitted,

W. Dee Trowbridge

W. Dee Trowbridge
Assistant Director

WDT/kvh

Saint Louis
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Laboratories, Inc.

2810 Clark Avenue
St. Louis, Missouri 63103
314/531-8080

December 19, 1978
Invoice No. 78-7016
Lab No. 3305

ENVIRONMENTAL RESEARCHERS OF EDWARDSVILLE
620 Montclaire
Edwardsville, Ill. 62025

REPORT OF ANALYSIS

MATERIAL: Twenty (20) water samples

TESTS REQUESTED: Chlorinated Hydrocarbons

RESULTS:

Samples #1H, #4H, #6H, #7H

Heptachlor Epoxide	<.06 mcg/l
Aldrin	<.05 mcg/l
Heptachlor	<.05 mcg/l
Dieldrin	<.05 mcg/l
DDE	<.05 mcg/l
DDT	<.10 mcg/l
Lindane	<.05 mcg/l
Chlordane	<.3 mcg/l
Endrin	<.10 mcg/l
Mirex	<.10 mcg/l
Methoxychlor	<.10 mcg/l

Sample #3H

Heptachlor Epoxide	<.07 mcg/l
Aldrin	<.05 mcg/l
Heptachlor	<.05 mcg/l
Dieldrin	<.05 mcg/l
DDE	<.05 mcg/l
DDT	<.10 mcg/l
Lindane	<.05 mcg/l
Chlordane	<.3 mcg/l
Endrin	<.10 mcg/l
Mirex	<.10 mcg/l
Methoxychlor	<.10 mcg/l

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Samples #2H, #5H, #8H, #9H, #10H, #11H, #12H, #13H, #14H, #15H, #16H, #17H, #18H, #19H, #20H

Heptachlor Epoxide	<.05 mcg/l
Aldrin	<.05 mcg/l
Heptachlor	<.05 mcg/l
Dieldrin	<.05 mcg/l
DDE	<.05 mcg/l
DDT	<.10 mcg/l
Lindane	<.05 mcg/l
Chlordane	<.3 mcg/l
Endrin	<.10 mcg/l
Mirex	<.10 mcg/l
Methoxychlor	<.10 mcg/l

Respectfully submitted,

W. Dee Trowbridge
Assistant Director

WDT/kvh

Saint Louis Testing Laboratories, Inc.

2810 Clark Avenue
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314/531-8080

January 31, 1979
Invoice No. 79-0514
Lab No. 78C1373

ENVIRONMENTAL RESEARCHERS OF EDWARDSVILLE
620 Montclaire
Edwardsville, Ill. 62025

REPORT OF ANALYSIS

MATERIAL: Twenty (20) sediment samples (winter)

TESTS REQUESTED: Chemical analysis

RESULTS:

	#1	#2	#3	#4	#5
COD, mg/l -----------	89	89	104	81	65
Copper, mg/l --------	<.01	<.01	<.01	<.01	<.01
Cyanide, mg/l -------	<.05	<.03	<.05	<.05	<.05
Iron, mg/l ----------	.13	.22	1.6	.39	.29
Lead, mg/l ----------	<.01	<.01	<.01	<.01	<.01
Manganese, mg/l -----	.17	.28	1.1	.96	1.2
Mercury, mg/l -------	<.001	<.001	<.001	<.001	<.001
Ammonia, mg/l -------	8.0	1.2	1.7	2.5	.58
Nitrate, mg/l -------	.16	.23	.34	.27	.25
Phenols, mg/l -------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ----	1.4	1.7	.70	1.4	1.1
Zinc, mg/l ----------	.02	.03	.03	.03	.01

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	#6	#7	#8	#9	#10
COD, mg/l ------------	169	88	145	101	89
Copper, mg/l --------	.06	<.01	<.01	.02	<.01
Cyanide, mg/l -------	<.01	<.01	<.01	<.01	<.01
Iron, mg/l ----------	.24	4.1	.26	3.4	.31
Lead, mg/l ----------	<.01	<.01	<.01	<.01	<.01
Manganese, mg/l -----	1.8	.50	1.1	2.7	.70
Mercury, mg/l -------	<.001	<.001	<.001	.001	.001
Ammonia, as N, mg/l -	.74	.30	.28	.72	2.8
Nitrate, mg/l -------	.52	.29	.32	.29	.29
Phenols, mg/l -------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ----	1.9	.90	3.0	2.3	1.2
Zinc, mg/l ----------	.02	.04	.01	.01	.03

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	#11	#12	#13	#14	#15
COD, mg/l ------------	48	125	185	105	144
Copper, mg/l ---------	<.01	<.01	<.01	.01	<.01
Cyanide, mg/l --------	<.01	<.01	<.01	<.01	<.01
Iron, mg/l -----------	2.1	.64	3.5	1.1	1.1
Lead, mg/l -----------	<.01	<.01	<.01	<.01	<.01
Manganese, mg/l ------	.04	.03	2.0	2.2	2.2
Mercury, mg/l --------	<.001	<.001	<.001	<.001	<.001
Ammonia, as N, mg/l -	.64	3.1	.48	8.8	5.2
Nitrate, mg/l --------	.13	.18	.20	.16	.18
Phenols, mg/l --------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ----	1.4	15	8.4	1.2	1.9
Zinc, mg/l -----------	.04	.01	.02	.03	.02

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	#16	#17	#18	#19	#20
COD, mg/l ------------	157	210	218	259	130
Copper, mg/l ---------	<.01	.01	<.01	<.01	<.01
Cyanide, mg/l --------	<.01	<.01	<.01	<.01	<.01
Iron, mg/l -----------	1.1	1.1	.64	2.1	1.0
Lead, mg/l -----------	<.01	<.01	<.01	<.01	<.01
Manganese, mg/l -----	2.6	3.1	2.2	.42	.31
Mercury, mg/l --------	.0016	<.001	<.001	<.001	<.001
Ammonia, as N, mg/l -	4.3	5.8	4.7	16	18
Nitrate, mg/l --------	.34	.20	.42	.45	.36
Phenols, mg/l --------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ----	4.8	4.4	4.2	2.6	2.5
Zinc, mg/l -----------	<.01	.01	.01	.02	<.01

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CHLORINATED HYDROCARBONS:

Sample #1

Heptachlor Epoxide, ppm	<.02
Aldrin, ppm	<.02
Heptachlor, ppm	<.02
Dieldrin, ppm	<.02
DDE, ppm	<.02
DDT, ppm	<.02
Lindane, ppm	<.02
Chlordane, ppm	<.19
Endrin, ppm	<.02
PCB, ppm	<.15
Mirex, ppm	<.02
Methoxychlor, ppm	<.02

Sample #2

Heptachlor Epoxide, ppm	<.02
Aldrin, ppm	<.02
Heptachlor, ppm	<.02
Dieldrin, ppm	<.02
DDE, ppm	<.02
DDT, ppm	<.02
Lindane, ppm	<.02
Chlordane, ppm	<.05
Endrin, ppm	<.02
PCB, ppm	<.15
Mirex, ppm	<.02
Methoxychlor, ppm	<.02

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Sample #3

Heptachlor, ppm	<.02
Aldrin, ppm	<.02
Heptachlor Epoxide, ppm	<.02
Dieldrin, ppm	<.02
DDE, ppm	<.02
DDT, ppm	<.02
Lindane, ppm	<.02
Chlordane, ppm	<.08
Endrin, ppm	<.02
PCB, ppm	<.15
Mirex, ppm	<.02
Methoxychlor, ppm	<.02

Sample #4

Hepachlor epoxide, ppm	<.02
Aldrin, ppm	<.02
Heptachlor, ppm	<.02
Dieldrin, ppm	<.02
DDE, ppm	<.02
DDT, ppm	0.04
Lindane, ppm	<.02
Chlordane, ppm	<.04
Endrin, ppm	<.02
PCB, ppm	<.15
Mirex, ppm	<.02
Methoxychlor, ppm	<.02

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Sample #

Heptachlor Epoxide, ppm	<.02
Aldrin, ppm	<.02
Heptachlor, ppm	<.02
Dieldrin, ppm	<.02
DDE, ppm	<.02
DDT, ppm	<.02
Lindane, ppm	<.02
Chlordane, ppm	<.04
Endrin, ppm	<.02
PCB, ppm	<.15
Mirex, ppm	<.02
Methoxychlor, ppm	<.02

Sample # 6

Heptachlor Epoxide, ppm	<.02
Aldrin, ppm	<.02
Heptachlor, ppm	<.02
Dieldrin, ppm	<.02
DDE, ppm	<.02
DDT, ppm	<.02
Lindane, ppm	<.02
Chlordane, ppm	0.02
Endrin, ppm	<.02
PCB, ppm	<.15
Mirex, ppm	<.02
Methoxychlor, ppm	<.02

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Sample # 12

Heptachlor Epoxide, ppm	<.02
Aldrin, ppm	<.02
Heptachlor, ppm	<.02
Dieldrin, ppm	<.02
DDE, ppm	0.04
DDT, ppm	<.02
Lindane, ppm	<.02
Chlordane, ppm	<.02
Endrin, ppm	<.02
PCB, ppm	<.15
Mirex, ppm	<.02
Methoxychlor, ppm	<.02

Sample # 16

Heptachlor Epoxide, ppm	<.02
Aldrin, ppm	<.02
Heptachlor, ppm	<.02
Dieldrin, ppm	<.02
DDE, ppm	<.02
DDT, ppm	<.02
Lindane, ppm	<.02
Chlordane, ppm	<.10
Endrin, ppm	<.02
PCB, ppm	<.15
Mirex, ppm	<.02
Methoxychlor, ppm	<.02

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Sample # 17

Heptachlor Epoxide, ppm	<.02
Aldrin, ppm	<.02
Heptachlor, ppm	<.02
Dieldrin, ppm	<.02
DDE, ppm	<.02
DDT, ppm	<.02
Lindane, ppm	<.02
Chlordane, ppm	<.03
Endrin, ppm	<.02
PCB, ppm	<.15
Mirex, ppm	<.02
Methoxychlor, ppm	<.02

Sample # 7, 8, 9,10, 11, 13, 14, 15, 18, 19, 20

Heptachlor Epoxide, ppm	<.02
Aldrin, ppm	<.02
Heptachlor, ppm	<.02
Dieldrin, ppm	<.02
DDE, ppm	<.02
DDT, ppm	<.02
Lindane, ppm	<.02
Chlordane, ppm	<.02
Endrin, ppm	<.02
PCB, ppm	<.15
Mirex, ppm	<.02
Methoxychlor, ppm	<.02

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MATERIAL: Twenty (20) water samples (winter)

	#1	#2	#3	#4	#5
Alkalinity as $CaCO_3$, mg/l ---	195	162	123	286	304
Fecal Streptococci, /100 ml -	67700	<10	20	580	230
Fecal Coliform, /100 ml -----	37100	<10	<10	510	1340
COD, mg/l -------------------	51	49	45	33	33
Chloride, mg/l --------------	137	135	157	63	80
Copper, mg/l ----------------	<.01	.01	<.01	.01	<.01
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	2.9	.96	.17	1.9	2.0
Lead, mg/l ------------------	<.01	<.01	<.01	<.01	<.01
Magnesium, mg/l -------------	30	28	25	38	47
Mercury, mg/l ---------------	.007	.001	<.0005	.002	.0025
Ammonia, as N, mg/l ---------	1.5	1.4	.81	.42	.37
Nitrate, mg/l ---------------	.98	.91	.78	1.0	.81
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	1.6	1.6	.05	1.3	.95
Specific Conductance, Micromhos/cm ---------	1490	1380	1355	1380	1580
Turbidity, NTU --------------	14	7.5	1.2	10	9
Zinc, mg/l ------------------	.07	.09	.02	.03	.05
Suspended Solids, mg/l ------	43	29	19	24	30
pH --------------------------	7.78	7.82	7.87	7.81	8.08

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	#6	#7	#8	#9	#10
Alkalinity as $CaCO_3$, mg/l ---	252	310	269	116	78
Fecal Streptococci, /100 ml -	560	440	600	6700	1800
Fecal Coliform, /100 ml -----	460	110	460	11100	30
COD, mg/l -------------------	16	23	55	84	76
Chloride, mg/l --------------	91	63	97	21	71
Copper, mg/l ----------------	.01	<.01	.13	.01	<.01
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	1.1	.23	2.5	1.3	.24
Lead, mg/l ------------------	.01	<.01	<.01	<.01	<.01
Magnesium, mg/l -------------	.34	37	45	7.3	48
Mercury, mg/l ---------------	.002	<.0005	.001	<.0005	<.0005
Ammonia, as N, mg/l ---------	.66	.18	.38	3.7	1.8
Nitrate, mg/l ---------------	1.9	.81	2.8	.45	.40
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	.32	1.0	.70	12	1.8
Specific Conductance, Micromhos/cm ---------	1610	1250	1510	595	2350
Turbidity, NTU --------------	3.8	5	17	15	41
Zinc, mg/l ------------------	.06	.02	.15	.06	1.19
Suspended Solids, mg/l ------	16	20	23	39	181
pH --------------------------	8.15	8.16	8.05	7.16	7.28

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	#11	#12	#13	#14	#15
Alkalinity as $CaCO_3$, mg/l ---	141	113	120	213	200
Fecal Streptococci, /100 ml -	7800	10	140	740	270
Fecal Coliform, /100 ml -----	680	<10	80	390	720
COD, mg/l -------------------	72	72	55	37	37
Chloride, mg/l --------------	26	46	41	59	41
Copper, mg/l ----------------	<.01	<.01	<.01	<.01	<.01
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	.56	.42	1.7	4.7	.45
Lead, mg/l ------------------	<.01	<.01	<.01	<.01	<.01
Magnesium, mg/l -------------	11	15	4	64	34
Mercury, mg/l ---------------	<.0005	.0025	.0090	.0015	<.0005
Ammonia, as N, mg/l ---------	.21	.16	.57	.64	1.28
Nitrate, mg/l ---------------	.05	.05	.03	1.1	.78
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	.25	1.0	6.9	1.3	2.9
Specific Conductance, Micromhos/cm ---------	680	815	615	1550	1190
Turbidity, NTU --------------	19	2.6	9	33	4.2
Zinc, mg/l ------------------	.04	.03	.04	.76	.03
Suspended Solids, mg/l ------	86	17	24	29	20
pH --------------------------	8.36	7.86	7.72	7.88	7.99

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	#16	#17	#18	#19	#20
Alkalinity as $CaCO_3$, mg/l ---	204	202	194	187	197
Fecal Streptococci, /100 ml -	70	420	120	360	330
Fecal Coliform, /100 ml -----	190	180	370	80	90
COD, mg/l ------------------	31	29	79	95	99
Chloride, mg/l --------------	55	76	38	33	34
Copper, mg/l ----------------	<.01	.09	.02	<.01	.04
Cyanide, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Iron, mg/l ------------------	.39	.74	3.4	4.2	3.8
Lead, mg/l ------------------	<.01	.01	.01	<.01	.23
Magnesium, mg/l -------------	36	36	15	16	15
Mercury, mg/l ---------------	<.0005	<.0005	<.0005	<.0005	<.0005
Ammonia, as N, mg/l ---------	1.4	1.6	.54	.28	.25
Nitrate, mg/l ---------------	.70	.88	2.0	2.0	2.0
Phenols, mg/l ---------------	<.01	<.01	<.01	<.01	<.01
Phosphates, mg/l ------------	2.7	2.9	1.3	1.9	1.1
Specific Conductance, Micromhos/cm ---------	1220	1340	860	770	760
Turbidity, NTU --------------	3.8	13	33	58	30
Zinc, mg/l ------------------	.02	.15	.05	<.01	.04
Suspended Solids, mg/l ------	16	57	128	312	95
pH -------------------------	7.89	7.80	8.28	8.30	8.34

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Sample #1, 2,3,5,6,7,8,9,10,11,12,13,14,18,19

Heptachlor Epoxide, mcg/l	<.05
Aldrin, mcg/l	<.05
Heptachlor, mcg/l	<.05
Dieldrin, mcg/l	<.05
DDE, mcg/l	<.05
DDT, mcg/l	<.10
Lindane, mcg/l	<.05
Chlordane, mcg/l	<.3
Endrin, mcg/l	<.10
Mirex, mcg/l	<.10
Methoxychlor, mcg/l	<.10

Sample #4

Heptachlor Epoxide, mcg/l	<.05
Aldrin, mcg/l	<.05
Heptachlor, mcg/l	<.05
Dieldrin, mcg/l	<.05
DDE, mcg/l	0.05
DDT, mcg/l	<.15
Lindane, mcg/l	<.05
Chlordane, mcg/l	0.35
Endrin, mcg/l	<.10
Mirex, mcg/l	<.10
Methoxychlor, mcg/l	<.10

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Sample #15

Heptachlor Epoxide, mcg/l	<.05
Aldrin, mcg/l	<.05
Heptachlor, mcg/l	<.05
Dieldrin, mcg/l	<.05
DDE, mcg/l	<.05
DDT, mcg/l	<.10
Lindane, mcg/l	<.05
Chlordane, mcg/l	0.35
Endrin, mcg/l	<.10
Mirex, mcg/l	<.10
Methoxychlor, mcg/l	<.10

Sample #16

Heptachlor Epoxide, mcg/l	<.05
Aldrin, mcg/l	<.05
Heptachlor, mcg/l	<.05
Dieldrin, mcg/l	<.05
DDE, mcg/l	<.05
DDT, mcg/l	<.10
Lindane, mcg/l	<.05
Chlordane, mcg/l	0.31
Endrin, mcg/l	<.10
Mirex, mcg/l	<.10
Methoxychlor, mcg/l	<.10

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Sample #17

Heptachlor Epoxide, mcg/l	<.05
Aldrin, mcg/l	<.05
Heptachlor, mcg/l	<.05
Dieldrin, mcg/l	<.05
DDE, mcg/l	<.05
DDT, mcg/l	<.10
Lindane, mcg/l	<.05
Chlordane, mcg/l	0.37
Endrin, mcg/l	<.10
Mirex, mcg/l	<.10
Methoxychlor, mcg/l	<.10

Sample #20

Heptachlor Epoxide, mcg/l	<.05
Aldrin, mcg/l	<.05
Heptachlor, mcg/l	<.05
Dieldrin, mcg/l	<.05
DDE, mcg/l	<.05
DDT, mcg/l	<.10
Lindane, mcg/l	<.05
Chlordane, mcg/l	0.30
Endrin, mcg/l	<.10
Mirex, mcg/l	<.10
Methoxychlor, mcg/l	<.10